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iVR in the Primary School Classroom: Pre-Service Teachers' Experiences, Insights and Motivation

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Abstract. Immersive virtual reality (iVR) educational applications enable students to interact with virtual environments through VR headsets and dedicated software, offering powerful opportunities for experiential exploration and engagement. The effective utilization of iVR demands evidence-based instructional design, supportive school conditions, and technological adequacy of devices and content. Literature worldwide highlights that teachers' insights and motivation for using iVR technology are important for achieving any expected educational value. The study discusses the experiences, insights and motivation of pre-service primary school teachers for the pedagogical use and values, benefits and challenges of the utilization of iVR applications in the classroom. Factors such as Attention, Relevance, Confidence, and Satisfaction while being involved in an immersive experience and the perception of iVR as a learning object in terms of Learning support, Quality of the application and Engagement, are under investigation. Twenty-one pre-service teachers participated in an educational intervention and their responses to the research tools revealed moderate to high values for Personal Propensity for Innovation, Attention, Relevance, Confidence, relatively moderate values for Conditions of Facilitation and high values for Satisfaction while being involved in an immersive experience, Learning support, Quality of the application and Engagement.

Keywords: Immersive Virtual Reality, Pre-service Teachers, Primary School Education, Motivation.

1 Introduction

The adoption of immersive virtual reality (iVR) in education has strongly influenced learning environments at all levels of education, exploiting high fidelity graphics and immersive content using head-mounted displays and supporting students to explore complex subjects in different ways than traditional teaching methods. Worldwide, research focuses on learning outcomes, pedagogical characteristics of interventions, and assessment measures, with most studies highlighting the advantages of utilizing iVR in education. However, most studies rely on short interventions, do not examine information retention, and focus primarily on scientific subjects such as biology or physics [1, 2]. Research on the use of iVR in primary schools is limited and highlights that pedagogically meaningful incorporation requires the integration of technological knowledge, pedagogical knowledge, and content knowledge (TPACK) so that technology effectively serves specific learning objectives and methods [3-5]. iVR can virtually immerse students in environments that are difficult to access (e.g., underwater ecosystems, geographical areas, or the universe), allowing for exploration and interaction [6]. In science education, iVR incorporates interaction and immediate feedback, with factors such as the sense of immersion and the degree of control and immediacy considered critical. Research focuses on both learning outcomes and cognitive and emotional processes such as increased engagement, but at the same time, a problem has been raised that it may interfere with learning by distracting attention, so careful pedagogical design and goal setting are required [7, 8]. In mathematics education, iVR applications have been introduced to support the lesson, aiming to engage children more enjoyably with authentic problems, as well as teaching with three-dimensional modelling to represent concepts and relationships in space [9, 10]. In language education, situated learning scenarios with iVR and technology architectures that combine communication infrastructures, cloud, and classroom iVR applications are proposed, with the aim of enhancing interaction. Improvements in teaching effectiveness have been recorded, reinforcing the argument that iVR can support not only "visualization" but also interactive communication scenarios [11]. More general educational reviews argue for a wide ecosystem of iVR hardware and software that is gradually being introduced into education to meet diverse learning needs [12]. Immersive "virtual field trips" have shown measurable benefits in knowledge construction and increased interest in scientific issues (e.g., climate change, ocean pollution), as well as more positive attitudes toward the environment [6]. Furthermore, iVR has been associated with increased motivation and support for understanding abstract concepts, while positive effects on skills and behavioral outcomes have also been reported [13].

On the other hand, systematic evaluation of iVR as an educational tool shows that robust experimental designs, careful measurement of quantitative outcomes and supportive implementation environments are required to allow teachers to implement iVR-supported teaching interventions [14]. At the same time, the performance and limitations of display/headset systems (visual architecture, display elements) affect the quality of experience and educational applicability [3]. Therefore, in primary school, iVR offers powerful opportunities for experiential exploration and engagement, but its effective use requires evidence-based instructional design, supportive school conditions, and technological adequacy of devices and content [1, 3, 14]. Teachers' intention to use iVR technology is a strong factor for achieving the expected educational value in elementary and secondary education. Literature reveals that perceived usefulness and perceived ease-of-usage significantly impact usage satisfaction, system quality and service quality of iVR technology are key factors influencing perceived usefulness and perceived ease-of-use and teachers are more concerned about optimizing pedagogical effectiveness by iVR technology. Moreover, a teaching and learning environment supporting the pedagogical application of iVR technology and a more autonomous classroom ecology for teachers may be important factors to promote teachers' usage intention for VR technology [4, 14-21].

This study investigates and discusses pre-service teachers' experiences, insights and motivation concerning iVR applications, based on the responses of participants in a short educational intervention during which they had an immersive experience in *Ancient Athens*.

2 Methodology

The study was a case study collecting and analyzing both quantitative and qualitative data and can be framed as an exploratory study that is context specific. Twenty-one (21) 4-year university students who attended an undergraduate university level program in Educational Sciences (pre-service teachers) participated in the study (eighteen (18) female and three (3) males with a mean age of 22.8 years old). All of them attended the course '*ICT in Education*', that is a course aiming to familiarize the students/future students with the use of ICTs in education integrating such tools into educational activities and scenarios according to learning theories and modern pedagogical approaches. A pre-questionnaire and a post-questionnaire, a focus group discussion and semi-structured interviews were used as research tools.

Fig. 1. Screenshots of the VR application.

The students visited immersively *Ancient Athens in 200 AD* walking through the *Agora*, visiting *Agrippa's Odeon* and the *theater of Dionysus*, flying over *Panathenaic Way*, and visiting the *Acropolis*, with the *Erechtheion*, the *Parthenon*, and the *chryselephantine statue of Athena Pallas*. The application of Ancient Athens is a faithful reconstruction of the archaeological site in the center of Athens and the Acropolis hill, created by the company LITHODOMOS. The reconstruction of the site is archaeologically accurate and created in UNITY, while the application was finalized in Blackmagic's DaVinci environment. One OCULUS GO set, by META, for each student used and the movie viewing synchronization supported by ShowtimeVR software. The application was an immersive video in which the participants watch a VR movie moving their heads in different directions following researchers' guidelines in order to all students have the same experiences. Figure 2 describes the phases of the procedure during the intervention. A pre-questionnaire (concerning demographical data, fundamental knowledge about VR and students' personal propensity for innovation [17]) and a post-questionnaire (based on RIMMS and LOES-S questionnaires as they adapted in the research of Villena-Taranill et al. [18] as well as on questions for Facilitation conditions as they used in the research of Paxinou, et al.[15]) were used. The pre-questionnaire consisted of twelve (12) questions and the post-questionnaire of thirty-three (33) questions. Both questionnaires were tested for validity and reliability. A back-translation procedure (English–Greek–English) was implemented. Three experts in the field of iVR applications in education reviewed the questionnaires to ensure content validity. A pilot administration of the pre-questionnaire to two (2) students before the course and a pilot administration of the post-questionnaire to the same two (2) students after the course ensured the face validity of the research tools. Cronbach's α coefficient was used to examine the internal consistency of the answers for the two questionnaires. The focus group discussion was based on four (4) questions concerning the intention of using iVR applications in classroom, challenges they may face, and the support and training they need. The semi-structured interviews were based on thirteen (13) questions based on the questionnaires used and concerning their positive and negative experiences from the intervention, an evaluation of the application they used and their insights concerning the pedagogical use of iVR in their classrooms as well as their needs.

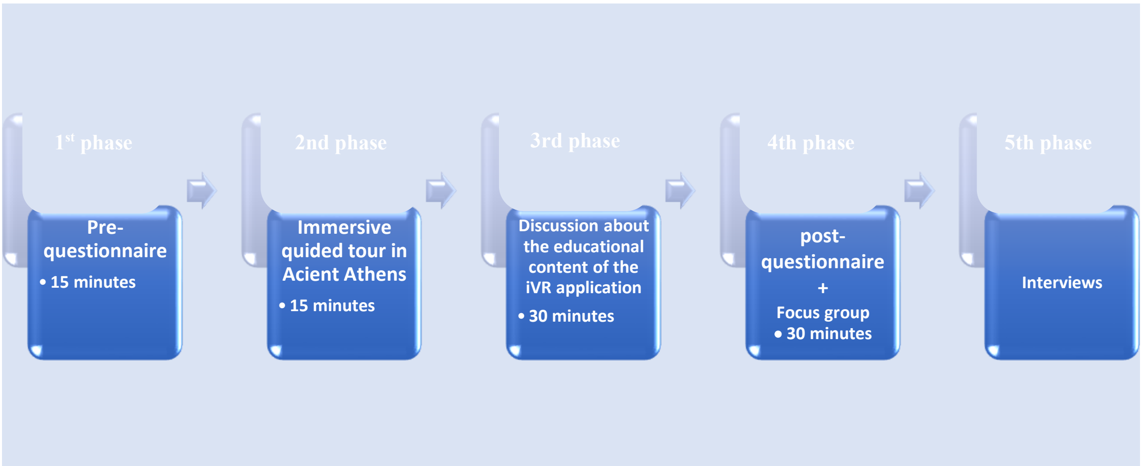

Fig. 2. The phases of the procedure during the intervention.

Descriptive statistical analysis is employed to analyze the data. The factors under investigation are: *Personal Propensity for Innovation, Conditions of Facilitation, Attention, Relevance, Confidence, Satisfaction while being involved in an immersive experience, Learning support, Quality of the application and Engagement.* The values of the factors were calculated by averaging the values of the responses to the individual questions that compose each factor. The Shapiro-Wilk normality test was performed, indicating non-normal distributions. A thematic analysis performed on the data of the interviews and the focus group discussion.

3 Findings

Cronbach's α coefficient was marginally acceptable for the pre-questionnaire (0.69) and highly acceptable (0.89) for the post-questionnaire. Measures of Central Tendency, of Dispersion and Asymmetry for each factor presented in table 1. Data analysis revealed *moderate to high* values for Personal Propensity for Innovation, Attention, Relevance, Confidence, *relatively moderate* values for Conditions of Facilitation and *high* values for Satisfaction while being involved in an immersive experience, Learning support, Quality of the application and Engagement.

Table 1. Measures of Central Tendency, of Dispersion and Asymmetry for factors of the study.

Factor	min	max	mean	median	St.Dev.	range	skewness	kurtosis
Personal Propensity for Innovation	2.40	4.20	3.48	3.60	0.40	1.80	-0.75	1.31
Conditions of Facilitation	2.25	3.38	2.83	2.87	0.26	1.13	0.19	1.28
Attention	2.00	4.67	3.56	4.00	0.77	2.67	-0.66	-0.49
Relevance	3.00	5.00	3.89	4.00	0.51	2.00	0.63	0.57
Confidence	2.67	4.67	3.68	3.67	0.65	2.00	0.29	-0.09
Satisfaction	3.33	5.00	4.39	4.33	0.56	1.67	-.037	-0.93
Learning support	3.00	5.00	3.95	3.80	0.58	2.00	0.21	-0.62
Quality of the application	3.00	5.00	3.97	3.75	0.61	2.00	0.40	-0.73
Engagement	3.33	5.00	4.33	4.33	0.55	1.67	-0.62	-1.31
Intention to use	3.00	5.00	3.84	4.00	0.79	2.00	0.28	-0.31

According to the interviews data analysis: All the students consider their involvement with the particular iVR application to be a positive experience. Among the positive factors resulting from the use of the iVR application, they mention an increase in student interest, increased student engagement and participation in the educational process, and an experiential approach to knowledge, while three (3) students mention a possible improvement in students' understanding of cognitive subjects. All of them agree that iVR tools would help their students learn more effectively, but they all mention dizziness as a negative aspect of this particular iVR application. All participants consistently reported that the technical infrastructure of schools is unsuitable and inadequate for the use of iVR applications and tools and that classroom management would be more difficult when using such applications and tools. Four (4) of the participants emphasize that no one will be able to offer them pedagogical or technical support when they need help using iVR applications and tools in their lessons, while one (1) participant argues that someone would be able to offer them pedagogical or technical support when they need help. All participants emphasize that it is essential for teachers to receive pedagogical and technical training in the use of iVR applications and tools in the educational process and refer to the ICT teacher as the person they expect to offer them pedagogical and technical support when needed. All participants also believe that their school will not support the use of iVR applications and tools in their teaching, as the necessary equipment and technical infrastructure will not be available, teachers will not be adequately trained, and fellow teachers, due to their older age, prefer traditional teaching methods that are difficult for them to abandon. All point out that the school curriculum obstructs the use of iVR applications and tools. Four students report that they will not be provided with suitable training opportunities during their in-service career at public schools due to the high cost of iVR applications and tools, while only one of the participants believes they will be provided with such training opportunities. Four (4) students argue that their training in the use of iVR applications for educational purposes will take place on their own initiative and of their own effort, and four (4) participants point out that their workload will make it difficult for them to receive training. Three (3) of the participants support the need for training in the use of iVR applications and tools for educational purposes during the undergraduate program in which they are enrolled. All of them note that those responsible for formulating and implementing educational policy do not substantially support the use of iVR applications in schools.

Fig. 3. Students during the intervention.

According to the Focus group data analysis: Pre-service teachers would like to use iVR applications to teach various subjects, as they stated that such kind of applications can be adapted to teach a variety of subjects. They reported that the feeling of dizziness their students may experience would discourage them from using iVR applications in their classroom although this depends on the quality of the graphics used by the application. They consider it difficult for schools to support the use of iVR applications in the classroom, as the cost of acquiring suitable virtual reality equipment for schools is extremely high. They do not believe that the state and authorities would offer them adequate training opportunities in the use of iVR applications in teaching, and any teacher who wants to be trained would have to take the initiative and do it on his/her own.

4 Conclusions

Analyzing the responses of the participants to the questions of the pre- and post-questionnaire moderate to high values for Personal Propensity for Innovation, Attention, Relevance, Confidence, relatively moderate values for Conditions of Facilitation and high values for Satisfaction while being involved in an immersive experience, Learning support, Quality of the application and Engagement, were derived. Their answers to the focus group discussion and the interviews revealed that they would like to use iVR applications to teach various subjects, despite the feeling of dizziness their students may experience but at the same time they consider it difficult for schools to support the use of iVR applications in the classroom, as the cost of acquiring suitable virtual reality equipment for schools is extremely high. They also do not believe that the state and authorities would offer them adequate training opportunities in the use of iVR applications in teaching and learning, and they should be trained by themselves. An important issue that arose was is the practicality of selecting appropriate headset VR experiences for primary age learners taking into consideration factors that minimize effects as 'dizziness'. The study is a case study that aims to contribute to the discussion about the pedagogical use of iVR applications and technology based on data concerning experiences, insights and motivation of pre-service primary school teachers. Future studies should be conducted using updated research tools, as iVR technology continues to rapidly evolve and impact educational practice.

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