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# Exploring the Potential of Immersive Virtual Reality in Italian Schools: A Practical Workshop with High School Teachers

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**Abstract:** In recent years, there has been a surge of interest in affordable and accessible extended reality devices. Big tech companies like Apple and Meta have announced advanced devices expected to become more prevalent in everyday life. As younger generations embrace immersive digital realities for socialization, entertainment, and information retrieval, there is a need to explore immersive digital technologies that support experiential learning and reevaluate educational approaches. In Italy, the COVID-19 pandemic has sparked a growing interest in immersive virtual reality (VR) and the metaverse for distance education. However, the integration of VR in Italian schools could be faster, primarily due to cost and teacher knowledge challenges. Our study aims to involve high school teachers in a practical workshop to assess their knowledge, skills, and intention to use VR in their teaching after brief training. The focus is on evaluating the acceptability of VR for educational purposes among Italian high school teachers. The workshop involved up to 16 teachers at once and was repeated eight times to reach 120 teachers. Participants received VR training and explored three educational VR applications. The results show that teachers are interested in learning and integrating VR into their lessons. They believe it can enhance teaching practices by actively engaging students and enabling experiential learning. This work provides an overview of the current state of VR in education, describes the workshop with high school teachers, and presents the obtained results.

**Keywords:** virtual reality; education; metaverse; learning experience



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## 1. Introduction

In recent years, we have witnessed the introduction of new extended reality devices, which are increasingly available in the market at affordable prices. As reported by IDC [1], partly due to new advanced devices announced by big tech companies, such as Apple and Meta, these devices are projected to become more prevalent in our homes, thus progressively permeating everyday life. Their growing presence, coupled with the increasing tendency of younger generations to interact with immersive digital realities for socialization experiences [2], entertainment, and even information retrieval [3], now necessitates a reevaluation of the pedagogical approach to education by exploring immersive digital technologies that support experiential learning [4].

Such headsets enable individuals to immerse themselves in digital experiences, including access to platforms commonly referred to as "metaverses". While there is no single, universally accepted definition of a metaverse, it is commonly described in the literature based on the following key characteristics: it features highly social aspects, unfolds within immersive and persistent 3D environments, and is accessible by multiple users across various platforms.

The integration of the metaverse into various sectors has commenced, offering the potential for enhanced industrial services and the fostering of a more sustainable society.

Concurrently, numerous studies have highlighted several obstacles associated with metaverse implementation. Given the fragmented literature on this subject within industries, a systematic review of research [5] pertaining to metaverse implementation was carried out. The findings of this review indicate that the integration of the metaverse into industries is at an early stage, primarily observed in the educational and healthcare sectors. Furthermore, there exists an uneven global distribution of research on metaverse implementation in industries, underscoring the need for increased international collaboration to facilitate its global adoption.

Additionally, it facilitates real-time user communication through embodied representations and dynamic interactions with digital objects [6].

In the literature review [7], the authors identify three primary types of VR:

- Full Immersive VR: This type of VR, often experienced through Head-Mounted Displays (HMD) and CAVE-based systems, offers a high level of immersion. In IVR, users are entirely immersed in the virtual environment, enhancing their sense of presence. IVR allows users to interact with the virtual world through bodily movements, such as head movements;
- Partial VR Environments: These environments offer a lower level of engagement because users simultaneously perceive the natural environment alongside the virtual one. This reduced level of engagement stems from the simultaneous perception of the real and virtual worlds within the user's field of view;
- Mixed Reality (MR): MR technology combines elements of Augmented Reality (AR) and VR, creating a continuum between the real and virtual worlds. It enables users to interact with virtual objects in the real world and experience depth and perspective in the environment.

The literature suggests that IVR technologies, including HMD, CAVE, and MR, provide various advantages in educational settings:

- Enhanced Learning Experience: IVR supports experiential learning by allowing students to practice and learn in safe environments, promoting authentic learning experiences [7–9];
- Increased Sense of Presence: IVR creates a higher perception of presence compared to non-immersive VR technologies, making the learning experience more engaging [8,10];
- Improved Learning Outcomes: IVR technologies are shown to enhance students' retention of concepts, knowledge transfer, and emotional engagement, ultimately improving learning outcomes [10–12].

Looking at instructional and practical design, prior experimental studies offer tangible proof and insightful details regarding the effectiveness and feasibility of utilizing VR across diverse computing devices to foster meaningful educational environments. Additionally, numerous studies have furnished quantitative evidence derived from course evaluations and user feedback, supporting the use of VR in education. While an ongoing stream of literature champions the success of VR-enhanced instruction, showcasing improved outcomes compared to traditional lecture-based formats, it is important to note the persistence of significant challenges observed across most studies [13].

Despite these advantages, there is no consensus in the literature about the overall effectiveness of IVR in the learning process. While some studies suggest its positive impact [14–18], others indicate no significant difference [19–23]. Table 1 shows in details the main outcomes of studies regarding VR effectiveness in education.

**Table 1.** The table describes the literature related to the VR effectiveness in learning.

| # | Study Description | Outcomes on Effectiveness |
|---|---|---|
| [14] | The impact of VR systems on the students' achievements in engineering colleges | Using any VR system dramatically improves the students' performance. |
| [15] | Using VR for enabling learners to be situated in simulated or imagined settings that contextualize their learning | Learners did not recall more details implied in learning; in VR they were able to build a better overall understanding of the learning material. |
| [16] | A systematic literature review of research conducted into virtual reality | The results are highlighted as effects in the learning process of the implementation of Virtual Reality in order of importance. These are: improving learning outcomes, living experiences that are closer to reality, intrinsic motivation, increasing the level of interest in learning and the skills. |
| [17] | How different approaches for designing medical educational tools affect students' learning performance | Regardless of whether different versions of a medical educational tool are perceived as equally useful and usable, the design approach (either 2D, 3D, or immersive virtual reality with or without gamification) affects students' retention of information on clinical cases. |
| [18] | A review of the use of virtual reality head-mounted displays in education and training | Results report an increase in effectiveness of learning outcomes when VR is used. |
| [19] | Laboratory experimentation in Digital Forensics | No significant differences in knowledge acquisition between IVR and traditional laboratory users. |
| [20] | Experimenting with IVR and PowerPoint for safety training | Results provide no robust evidence for an effect of the presentation medium. |
| [21] | Laboratory safety training experimentation | Groups using IVR, Desktop VR, and Text-based manual did not differ in immediate retention test, suggesting media equivalence in conveying basic knowledge. |
| [22] | Literature review | Positive attitudes among students and teachers towards IVR; limited knowledge on retention. Few studies show positive learning results in IVR. |
| [23] | Experiment on students' understanding during a virtual tour | Users may experience discomfort and poor headset tolerance, negatively affecting learning. |

Moreover, in this context we may refer to the UN Sustainable Development Goals (SDGs). Back in 2015, the 2030 Agenda for Sustainable Development received the green light from United Nations Member States, ushering in the adoption of the SDGs. This Agenda is recognized globally as a comprehensive action plan devised to eliminate poverty and propel sustainable development across five fundamental dimensions: individuals, the environment, economic well-being, peace, and collaborative partnerships [24]. Within the realm of the SDGs, a cluster of 17 objectives and 169 targets can be found that demand sweeping transformations in economic, social, and environmental aspects, applicable to both developing and developed settings [25,26]. In recent years, these goals have gained significant prominence. Furthermore, the SDGs encompass the enhancement of education, leveraging the participation and support of higher education institutions (HEIs) that wield the potential to actively engage in sustainability efforts and drive the realization of these objectives [27].

Virtual Reality can be a powerful tool for training and education, thus contributing to the achievement of the SDGs related to quality education (SDG 4) and the promotion of awareness and education on sustainability matters (SDG 4 and SDG 12) [28]. In [29], the authors emphasize the importance of education for sustainable development and the key role that universities can play in promoting sustainability through education. They argue that university institutions should lead the sustainability movement by providing relevant content to students and developing knowledge. To achieve this, changes to curricula are necessary, along with the implementation of training initiatives that reorganize programs and skills considering sustainable criteria. The goal is to transform knowledge in education for sustainable development into critical systemic thinking and action. In [30], the authors show that virtual reality can appropriately support different SDGs, particularly Goal 4. It can ensure inclusive and equitable quality education and promote lifelong learning opportunities for all by offering educational programs. For instance, VR can simulate real-life scenarios and provide hands-on training for students in fields such as medicine, engineering, and architecture. Additionally, VR can grant access to educational resources and experiences not readily available in traditional classrooms, such as virtual field trips to historical sites or museums. By providing inclusive and equitable access to quality education, VR can contribute to promoting lifelong learning opportunities for all.

In Italy, schools' interest in immersive virtual reality and the metaverse has gained momentum since 2020, the year of the COVID-19 outbreak. This is because VR can be employed in distance education [31], and the Italian National Recovery and Resilience Plan (PNRR) includes funding opportunities for investing in metaverse-enabling systems.

However, the practical implementation of IVR and the metaverse in Italian schools continues to exhibit sluggish progress, primarily characterized by the confinement of its utilization to modest experimental undertakings rather than its integration within the regular curricula. In [32], the authors also found that the use of VR in schools is still in its early stages. There are several challenges that need to be addressed before VR can be widely adopted in schools, such as the cost of the technology and the lack of knowledge for teachers. According to researchers in [33–35], the metaverse has the potential to enhance the educational experience, particularly in the context of the teacher—student relationship, which, when operating within the metaverse, is free from constraints related to time and location. Furthermore, the metaverse plays a pivotal role in the transformation of the conventional educational model, which has historically been static. Instead, it introduces a dynamic model that incorporates diverse scenarios, methods, tools, and modes of learning and assessment, with a strong focus on placing the student at the core of the educational process. This, in turn, has the potential to boost student motivation for learning.

A systematic literature review indicates that employing Social Virtual Reality Environments could offer genuine, simulated, cognitively demanding experiences within captivating, motivating settings for unstructured social interactions and collaborative engagements, fostering intentional, personalized learning. Specifically, it is associated with profound and meaningful learning processes [36].

However, its application in Italian educational field is still at the early stages and research on this topic is still scarce [35].

Virtual Reality has already been extensively studied as a supportive educational tool [37,38]. Many studies have employed methodologies such as focus groups, questionnaires, and experiments with student groups [39], demonstrating improvements in learning outcomes, particularly in the scientific fields [40,41].

Nevertheless, due to the nature of VR, which enables the digital reconstruction of immersive experiences in any real or fictional contexts, these technologies have the potential to find applications in all disciplines. This includes humanities subjects, such as historical reconstructions, virtual tours, situated language learning, and more, as well as scientific subjects, encompassing simulations of chemistry or physics laboratories and even space exploration [42].

As shown by the systematic review by [43], studies on IVR and learning have involved school students in experimental projects, but not directly teachers, who instead have a key role in the systematic and structural adoption of VR within regular courses. The contribution of our work is to involve schoolteachers directly in a practical workshop to study their level of knowledge of the technology, their skills, and their intention to use it in their own courses after some training in VR. The aim of this study is to evaluate the acceptability of VR for educational purposes among high school teachers in Italian schools. Specifically, the study aims to investigate teachers' experiences with three potential VR applications for instructional use.

This assessment encompasses examining the teachers' perception of the applications' ease of use, the perceived level of student engagement, the utility they find in these applications, and, more generally, in VR.

Ultimately, the study seeks to gauge the teachers' intention to incorporate VR into their teaching practices.

To achieve these objectives, we conducted a workshop involving up to 16 teachers at once and repeated eight times to reach 120 teachers from various grade levels. During the workshop, the teachers received a brief training session on using VR in education. They had the opportunity to experiment with three potential educational IVR applications using a VR headset.

The three IVR applications included the following:

1. Horizon Workrooms: A VR coworking app used for distance learning purposes;
2. Meta Horizon TV: A VR video player used for immersive video visualization in groups, enabling virtual tours for students and teachers together;
3. Immerse: A language-learning app for situated language acquisition.

All three applications utilized avatars provided by the Meta operating system and employed a consistent communication and interaction system using controllers within the virtual environment. Participants were required to perform educational tasks using each application to understand the potential benefits for learning and the possible student experience.

Following the workshop, participants' experiences were evaluated through a multiple-choice questionnaire.

As suggested by [8], despite the numerous studies and experiments that propose the integration of VR into traditional classrooms [7], this integration remains unrealized. What is lacking in the existing literature is a practical approach that directly engages those who will be responsible for delivering lessons through VR, namely high school teachers, and elucidates both the advantages and challenges in the use and ultimate adoption of immersive VR in secondary education.

Our work provides an exploration of the potential of VR in education, with a focus on the perspectives of high school teachers and students in Italy. It includes a workshop involving 120 Italian high school teachers, as well as feedback and observations from teachers and students. The paper also reviews relevant literature on VR and learning and discusses the advantages of VR over other similar technologies. While numerous researchers have investigated the potential application of VR in education in the past decade, this paper stands out for its comprehensive exploration of the topic in the context of Italian high schools and for involving directly high-school teachers in the experimentation and evaluation of the technology and its potential adoption.

The structure of this work is organized as follows: Section 2 provides an overview of the current state of VR related to education. It also describes the workshop conducted, involving 120 high school teachers, to explore their perspectives. Section 3 presents the obtained results, followed by a discussion. Limitations, conclusions, and future work are presented in Section 4.

## 2. Materials and Methods

In this section, we present the relevant literature on VR and learning, the design and execution of the workshop used as a research tool, the applications utilized, the corresponding tasks, and finally, the survey administered to the workshop participants.

### *2.1. Related Work*

In the past decade, numerous researchers have extensively investigated the potential application of VR in education, encompassing schools and academic institutions as well as other learning settings. The focus is directed towards the most recent studies, as the advancement of this technology, coupled with cost reductions, has rendered the earlier ones relatively less significant [43,44].

In comparison to analogous technologies such as augmented reality [45] and mixed reality, VR has the property of transporting users away from the physical realm and immersing them within a fully simulated setting [43,44,46,47].

This property gives rise to several advantages that can be effectively leveraged in educational contexts [44,46,47]. Specifically, users of VR experience a heightened sense of presence [48] within the artificial world, akin to what they encounter in the real world. This heightened sense of presence enables them to interact with simulated environments, often challenging or impossible to replicate in reality [49]. In addition, the immersive quality of the VR experience provides advantages in surmounting potential obstacles to effective learning [50], particularly concerning external distractions. A pertinent example lies in the domain of remote learning [51], where VR helps to address the issue of perceived spatial separation among participants. VR's sense of presence and immersion emerge as pivotal facets of effective pedagogy, as they can also transcend the spatial and temporal constraints inherent in the educational environment [52].

VR has been the subject of extensive investigation within various domains of education, encompassing language learning [53,54], history learning [7], surgical education [55], engineering education [56], and heritage education [57]. Particularly noteworthy are recent meta-analyses and reviews conducted by scholars such as [57–59]. Of particular relevance, [58] delves into the application of VR in elementary education spanning the K-6 grade levels, while [59] focuses on its utilization in K-12 and higher education contexts.

Some research has been done on understanding the value of introducing 360° videos in learning [7,55,60,61]. The authors pointed out that 360° has several positive effects regarding student performance, motivation, and knowledge retention, which is one of the reasons why we chose to include an immersive video application in our workshop.

### *2.2. The Workshop on Virtual Realities for Education*

To assess teachers' experience in using immersive VR applications for educational purposes, we designed a workshop involving 120 high school teachers. The workshop was developed in collaboration between the Disability Research Center (DRC) at the International University of Rome (UNINT), the Virtual and Augmented Reality for Learning working group at UNINT, and the Regional School Office of Lazio (Italy), which disseminated the invitation to teachers in the region. The workshop was offered to teachers as a professional development activity in VR, and upon completion they received an official participation certificate provided by the DRC, which was valid for training credits.

The workshop was organized in the Aula Magna (lecture hall) of UNINT in eight sessions, each accommodating up to 16 teachers at a time. Additionally, four researchers participated as presenters, and two as observers. The technical staff from UNINT was present to address any technical issues related to the VR headsets. The division of teachers into sessions of 16 participants was determined to facilitate workshop management and to avoid overburdening the network connection, as managing multiple VR headsets consumes substantial resources. Additionally, the limit of 16 participants per session was practical to ensure stability.

A single workshop session was structured into several phases. In the initial phase, an introduction to VR in education was provided (15–20 min). The second phase (15–20 min) presented VR in relation to other extended digital realities and explained the technical functioning of the Meta Oculus Quest 2 (https://www.meta.com/it/quest/products/quest-2/, accessed on 16 October 2023) VR headset, which was used for the practical part of the workshop. In the final phase (50–70 min), three educational applications were explained and experienced: Horizon Workrooms for distance learning, Meta Quest TV for virtual tours, and Immerse for situated language learning.

The Aula Magna features two floors and provides ample space to accommodate seating for up to 100 people. Additionally, it offers large areas dedicated to speakers, assistants, technicians, and video production control. This allowed us to ensure proper distancing among the 16 participants while experimenting with VR applications, enabling them to communicate and move within the virtual world without disturbing others.

In the workshop, most participants, accounting for 92.7%, were female, while the remainder were male. In terms of age, about 30.9% fell within the 44 to 54 age range, indicating a substantial presence of mid-career educators. Additionally, 10.9% were over the age of 54. Another 10.9% of participants were relatively young, aged between 22 and 32, while the most significant portion, 47.3%, was in the 33 to 43 age bracket.

Regarding the educational institutions where they teach, 18.2% are associated with primary schools, while a significant 36.4% teach at secondary schools of the second degree. Furthermore, 27.3% were affiliated with secondary schools of the first degree, and the remaining participants were spread across other educational levels.

Geographically, the majority of the participants, 83.6%, hailed from the central region of Italy, and the rest were from the southern region of Italy.

When it came to the subjects they teach, various disciplines were covered. Notably, 30% of the participants specialized in supporting students with disabilities, highlighting an interest in VR for inclusive education. Additionally, 17.5% focused on artistic and musical disciplines, while 14.3% were involved in teaching foreign languages. Italian and Latin studies were the primary focus for 10% of the participants, and 21.9% were dedicated to mathematics, physics, natural sciences, and technology subjects. The remaining educators represented various other disciplines, each contributing less than 2%.

Most workshop participants, precisely 98.2%, expressed a proactive attitude towards new technologies. They indicated a strong willingness to study and experiment with emerging technologies in their daily lives and professional work. Moreover, 72.7% had not previously experienced VR, and 90.9% had not previously incorporated VR into their educational practices, highlighting the novelty of the technology for a significant portion of the teachers, emphasizing the potential impact of the workshop in introducing this technology to the participants' pedagogical toolkit.

### *2.3. VR Applications and Experience Scenarios*

In this section, we illustrate the three applications used in the workshop and the experience scenarios assigned to the participants. Such scenarios are designed to measure the teachers' perceptions about the usability, students' engagement, the usefulness, and the intention of use of IVR in education. The experience scenarios are structured as follows: description of the IVR application, use scenario, task.

1. Application: Horizon Workrooms (https://www.oculus.com/experiences/quest/2514011888645651/, accessed on 16 October 2023) is an application designed to facilitate collaborative work within a virtual space. It offers various types of rooms, including co-working spaces, conference rooms, and classrooms. Participants (or, in our case, teachers) are unable to move freely within the virtual space but can change their virtual chair if another is available. Within the classroom, features such as slide projection, Zoom connectivity, a virtual chalkboard, and the ability to bring their own PC screen for note-taking in VR are available. Participants can communicate with their peers and the presenter using multimodal communication, combining voice and

gestural interactions, thus simulating interactions resembling those in the real world. Participants were asked to attend a brief presentation on the Workrooms platform and interact with their peers and the presenter to understand its functionality.

Scenario: Due to a public health emergency, school classes are being conducted remotely. You are participating in a technology-enhanced learning class within an immersive virtual space.

Tasks: Wearing the VR headset, (a) access Horizon Workrooms, (b) select a comfortable seat for viewing the presentation, (c) listen to the brief presentation by the instructor, who is represented as an avatar, and the instructor connected via Zoom, (d) when prompted, use the shared virtual whiteboard on your desk to display keywords representing what you have learned today, (e) when asked, engage in discussions with your peers and the instructor, providing comments on the keywords written by your fellows.

Learning outcomes: Educators gain proficiency in utilizing the integrated interactions and tools within Horizon Workrooms to facilitate multimodal and immersive communication during remote learning sessions. Furthermore, they immerse themselves in the role of students to gain a comprehensive understanding of how students experience the lesson and what difficulties they may encounter during it.

2. Application: Meta Quest TV (https://www.oculus.com/experiences/quest/1931356740318898/ accessed on 16 October 2023) is a multimedia player that can display both 2D and immersive videos on a VR headset. The unique feature of this application is that users can view and navigate immersive videos with their avatars, along with other connected users. This enables group viewing experiences that transform into virtual group tours. As a learning task, participants were required to take part in two short virtual group tours. The first tour involved exploring the Alhambra in Granada, Spain, and the second tour allowed them to experience the surface of Mars through a virtual video recorded by the Curiosity rover.

Scenario: The school has organized virtual educational field trips to enable students to visit distant or otherwise inaccessible locations. These virtual excursions can be experienced in a blended format, either from home or in a classroom, thereby allowing students who are absent, for example due to illness, to participate as if they were present.

Tasks: (a) Having already donned your virtual reality headset, open the invitation message to share the video experience "Visiting Alhambra". (b) Accept the invitation and await the guide's instructions. (c) Once all your peers are connected, the guide will initiate the video. (d) Listen to the explanation and engage with the guide and your peers. (e) Repeat the task with the second invitation to share the video experience "Visiting Mars".

Learning Outcomes: Educators acquire the skills to navigate and interact within a virtual video environment. They gain an understanding of the potential for leveraging immersive videos to create informal, secure, and quick learning experiences. Additionally, they immerse themselves in the students' perspective, gaining insight into the challenges that may arise when accessing and engaging with the video content in the presence of their peers.

3. Application: Immerse (https://www.immerse.com/, accessed on 16 October 2023) is an application designed for situated language learning. It provides various situated learning environments where specific tasks can be designed to help students learn words within a given context or encourage interaction and dialogue among students. Unlike in Workrooms, students have the freedom to move and interact within virtual environments, engaging in multimodal communication through voice, gestures, and body movements. Furthermore, in the Immerse app, users have access to a backpack containing various tools, including a camera, a laser pointer and an object scanner that detects the name of the object and pronounces it in the target language of learning. Two simple tasks were designed by an English teacher and executed by the participants.

The primary objective of these tasks was to explore the potential benefits of this platform for language learning, while also providing participants with an immersive student experience. Each task presented participants with simple yet intellectually stimulating operations, and what made them intriguing for language learning was the deliberate use of English as the mode of teaching and interaction throughout the whole procedure. The intention behind this approach was to facilitate the acquisition of specialized vocabulary and terminology by actively engaging participants in the required actions.

Scenario 1—Investigative Activity in English: students were part of an investigative activity where they needed to find hidden objects in a room. Clues were provided in English, containing cryptic information about where to find the objects. Students applied their problem-solving skills and English comprehension to decode the clues and locate the objects. Scenario 2—Collaborative Cooking Simulation in a Virtual Room: in this scenario, students engaged in a collaborative cooking simulation within a virtual room. They were given a recipe, along with a list of ingredients hidden within the room. It was their task to find the ingredients and collaborate in grouping them together on a shared desk, following the recipe's instructions.

Task 1: Wearing the VR headset, (a) access the Immerse virtual room specifically designed for the activity, (b) read the information and clues about the items to be found, (c) establish a collaborative tactic with teammates, (d) find the items, (c) take a photograph of each of them through the virtual camera held in the backpack. Task 2: Wearing the VR headset, (a) access the Immerse virtual room specifically designed for the activity, (b) read the recipes and the list of the ingredients provided by the instructor, (c) establish a collaborative tactic with teammates, (d) find the ingredients, (e) group all ingredients together.

Learning outcomes 1 and 2: Educators will acquire expertise in leveraging the integrated features and functionalities of the Immerse platform rooms to support diverse and immersive activities that foster active learning, collaboration, practical English usage, and the cultivation of various skills such as reading, observation, and adherence to instructions. Additionally, the teachers participate in the activities as students to gain a thorough understanding of how the students experience them and to identify any challenges they may face.

The three presented applications share a similar interaction design, relying on identical avatars and the use of controllers to track movements. Since only two of these applications allow for a beta version of hand tracking, it was decided to use only the controllers during the workshop.

### *2.4. Teachers' Survey*

The purpose of this survey is to assess teachers' perceptions and the ease of integrating VR into their regular courses. Specifically, the study aimed to determine the usefulness of VR compared to their previous experiences and their intention to use VR in the future. Due to the limited time available for teachers to participate in the workshop alongside their normal activities, a questionnaire was chosen as a practical and non-intrusive method, rather than conducting additional activities such as focus groups or interviews.

The questionnaire used in this study was based on the technology acceptance model (TAM) and was modified to evaluate the teachers' experience while using VR in educational applications. Previous studies have employed adapted versions of the TAM to explore students' experiences when using new methods or tools during regular classes [62,63].

The questionnaire consisted of 19 items, categorized into four scales: perceived ease of use (EU) of VR applications, potential student engagement (EN), perceived usefulness (PU), and intention to use (IU) in regular classes. Table 2 presents the individual items of the survey described by their ID, the number of participants who responded, their respective mean, and standard deviation.

**Table 2.** The survey items with related mean and standard deviation.

| ID | Item | N. | Mean | S.D. |
|---|---|---|---|---|
| EU1 | Communicating in Virtual Reality is easy | 120 | 3.5 | 0.9 |
| EU2 | Focusing attention on the didactic task in Virtual Reality is easy | 120 | 3.7 | 0.8 |
| EU3 | Interacting with the virtual interface is easy | 120 | 3.6 | 0.9 |
| EU4 | Keeping the Virtual Reality headset on during tasks is easy | 120 | 3.7 | 1.1 |
| EU5 | Overall, I find it easy to participate in VR tasks | 120 | 3.9 | 0.8 |
| EN1 | I believe that Virtual Reality technology can stimulate students while learning in the classroom | 120 | 4.6 | 0.8 |
| EN2 | I believe Virtual Reality technology can inspire students while learning at home | 120 | 4.6 | 0.8 |
| EN3 | I believe that Virtual Reality technology can help increase students' attention towards educational activities | 120 | 4.7 | 0.8 |
| EN4 | I believe that Virtual Reality technology can help make educational activities more enjoyable for students | 120 | 4.7 | 0.7 |
| PU1 | I believe that Virtual Reality can help to better understand the content of a lesson | 120 | 4.4 | 0.8 |
| PU2 | I find situated learning in Virtual Reality helpful | 120 | 4.6 | 0.8 |
| PU3 | I find group viewing of Virtual Reality videos useful for teaching | 120 | 4.6 | 0.8 |
| PU4 | In general, I find Virtual Reality videos useful for learning | 120 | 4.6 | 0.8 |
| PU5 | I find Virtual Reality useful for distance learning | 120 | 4.6 | 0.8 |
| PU6 | With ad hoc applications, I would find Virtual Reality useful for the subjects I teach | 120 | 4.4 | 0.9 |
| PU7 | Overall, I find Virtual Reality useful for teaching | 120 | 4.7 | 0.7 |
| PU8 | Overall, I find VR useful for presentations | 120 | 4.6 | 0.8 |
| IU1 | I would like to try Virtual Reality technology in one of my classes | 120 | 4.6 | 0.7 |
| IU2 | I would recommend colleagues try Virtual Reality technology in their courses | 120 | 4.7 | 0.8 |

The questions in the survey were rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). This approach, as indicated in previous research, is considered to enhance both the response rate and the quality of responses while also minimizing the level of frustration experienced by participants [64,65].

Prior to conducting the analysis, we assessed the questionnaire's reliability according to the guidelines suggested in [66] for questionnaires with a limited sample size ranging from about 30 to 100 participants. The reliability test was performed using Cronbach's Alpha coefficient [67] for each scale. Our results indicated values exceeding 0.6, in line with the recommendations provided in [68,69].

Specifically, the following values were obtained: EU $\rightarrow \alpha = 0.77$, N = 5; EN $\rightarrow \alpha = 0.96$, N = 4; PU $\rightarrow \alpha = 0.93$, N = 8; and IU $\rightarrow \alpha = 0.69$, N = 2. Hence, the preliminary findings from the questionnaire demonstrate satisfactory reliability, which was further supported by the researchers' observations.

It is worth noting that only IU slightly surpasses the threshold of 0.7. This implies a moderate internal reliability of the items within this scale. However, it is important to acknowledge that the limited number of items (2) could potentially impact this value.

Moreover, the standard deviation can be used to analyze the similarity of responses for an individual item in the survey. A low standard deviation indicates that the responses are similar to each other, indicating consistency of the single item. As shown in Table 2, all standard deviations are below or equal to 0.8 except for EU1 (0.9), EU3 (0.9), EU4 (1.1) and PU6 (0.9), which are related to the ease of interacting and communicating in the virtual world, the ease of wearing the VR headset, and the perceived utility. These items warrant further investigation to understand their underlying factors more comprehensively.

Finally, we analyzed the results by categorizing participants into specific groups. They were divided based on age, with one group aged 22 to 43 (comprising 70 teachers) and another group aged 44 or older (comprising 50 teachers). Additionally, participants were classified into three major areas of study: STEM (26 teachers), humanities (58 teachers), and disabilities support (36 teachers).

To assess potential differences, we applied the nonparametric Mann—Whitney test to compare questionnaire item means between the two age groups and the nonparametric Kruskal—Wallis test to compare the three subject groups. These procedures are deemed appropriate for testing variations between conditions and different participants, especially when comparing means on Likert scales [70].

However, despite these stratifications, the analysis of item comparisons on each scale yielded $p$-values greater than 0.05. It indicates that the varying ages or the teaching subjects do not significantly influence the teachers' perceptions. The cumulative descriptive statistics consistently show similarities across age groups and among educators from different subject areas.

## 3. Results and Discussion

The study's results are presented in Table 2, displaying the mean scores and standard deviations for each item assessed by the participating teachers (N = 120).

Regarding the ease of communication in virtual reality (EU1), the teachers reported a mean score of 3.5 (SD = 0.9), indicating a generally positive but moderately perceived ease. However, the standard deviation suggests a relatively high level of variability, indicating that some users found the interaction extremely easy while others had some reservations. Similarly, focusing attention on the didactic task in virtual reality (EU2) and interacting with the virtual interface (EU3) received mean scores of 3.7 (SD = 0.8) and 3.6 (SD = 0.9), respectively, indicating a favorable perception of ease despite the relatively variable standard deviations observed.

Regarding wearing the VR headset during tasks (EU4), the teachers expressed a mean score of 3.7 (SD = 1.1), suggesting that wearing the headset was relatively manageable for most of them. However, as indicated by the standard deviation, some participants encountered difficulties or initially struggled to adapt, which was also observed by the researchers present in the room. Moreover, the overall ease of participating in VR tasks (EU5) received a mean score of 3.9 (SD = 0.8), indicating a generally positive perception of ease among the teachers.

Regarding the perceived impact of VR technology on student learning experience, the teachers demonstrated high levels of agreement. They strongly believed that VR technology could stimulate students while learning in the classroom (EN1) and inspire students while learning at home (EN2), with mean scores of 4.6 (SD = 0.8) for both items. Furthermore, they agreed that VR technology could help increase students' attention towards educational activities (EN3) and make educational activities more enjoyable for students (EN4), with mean scores of 4.7 for both items.

Regarding the usefulness of VR in teaching, the teachers expressed positive attitudes. They believed that VR could help them better understand the content of a lesson (PU1), with a mean score of 4.4 (SD = 0.8). They also found situated learning in VR (PU2), group viewing of VR videos (PU3), and VR videos for learning in general (PU4) to be useful, with mean scores of 4.6 (SD = 0.8) for all three items. Additionally, the teachers found VR useful for distance learning (PU5), receiving mean scores of 4.6 (SD = 0.8), as well as for the subjects they teach with ad hoc applications (PU6), receiving mean scores of 4.4 (SD = 0.9).

Overall, they perceived VR as highly useful for teaching (PU7) and presentations (PU8), with mean scores of 4.7 (SD = 0.7) and 4.6 (SD = 0.8), respectively.

Furthermore, the teachers expressed a strong interest in incorporating VR technology into their teaching practices. They reported a mean score of 4.6 (SD = 0.7) for the item, indicating their willingness to try VR technology in one of their classes (IU1). Moreover, they expressed a high level of recommendation, with a mean score of 4.7 (SD = 0.8), indicating their willingness to recommend colleagues to try VR technology in their courses (IU2).

Overall, the results indicate a positive perception of ease, usefulness, and intention to adopt VR technology among the participating teachers, suggesting a potential for further integration of VR in educational settings.

The participants' comments left at the end of the questionnaire revealed several insights and considerations regarding the use of VR in education.

Firstly, VR was perceived as a powerful tool for promoting inclusivity in the classroom by leveling the playing field and minimizing differences among students. This is because, within controlled virtual worlds, all students have equal characteristics and opportunities. However, it was noted that careful consideration should be given to ensuring the inclusion of all students, including those with special educational needs.

Moreover, it was also pointed out that there is a need for increased awareness and support for digital technologies in Italian schools. Many schools need more resources, and economically disadvantaged students often need help to afford primary devices like computers or tablets. This highlights the importance of inclusive educational policies ensuring equal access to technological tools.

Participants believed VR can enhance teaching and learning experiences by generating greater interest in the subject matter. The immersive nature of VR was highly valued, as it was seen as a means to captivate students' attention and stimulate their curiosity. Specifically, in foreign language classes, VR was regarded as a valuable tool for creating a fully immersive cultural experience.

Some participants highlighted the potential of VR in preventing and managing problematic situations, such as bullying. Indeed, by simulating scenarios close to real life, they suggest VR can foster understanding and empathy among students.

While the overall reception of VR was positive, some participants mentioned initial challenges with wearing the VR headset and adapting to the technology. It was acknowledged that training and familiarization with the VR devices and interfaces are essential for optimal usage.

Suggestions were made for creating comprehensive training programs for teachers and allocating funds to equip classrooms with VR devices. Additionally, participants recommended expanding the application of VR across various subjects to maximize its educational benefits.

The workshop on VR has sparked both interest and curiosity among teachers, resulting in active engagement across different age groups and subject areas. Teachers have demonstrated a keen interest in the experimented applications, considering how they can incorporate them into their courses and collaborate with colleagues to enhance student learning through experiential education.

During the workshop, teachers raised concerns mainly about the intuitiveness of the applications and system interfaces, as well as the ergonomics of the VR headset. Despite some initial challenges, they managed to use all the applications effectively. Therefore, they consider initial technical and competent support necessary for using VR during a regular class. Another notable concern that emerged was related to the teachers' competencies. Many admitted a lack of knowledge in both the subject matter and the VR tool, fearing that without proper training, students might surpass their expertise, creating inconvenience for teachers and potentially hindering the systematic adoption of VR in the classroom.

Furthermore, some teachers expressed reservations about the optimal usage duration of a VR headset during a course. They worried that extended use might distract students, turning the learning experience into a game and rendering traditional teaching methods ineffective.

To address these concerns and foster successful integration of VR in education, teachers should be provided with comprehensive training programs. Ensuring they possess both the technical expertise and the confidence to utilize VR effectively will enhance their ability to leverage the technology as a powerful educational tool. Additionally, carefully curating VR experiences to balance engagement and focused learning can maximize its impact on students' cultural growth.

Five learned lessons can be gleaned from the findings and participant comments. The lessons were developed through a rigorous process involving the interpretation of data, observations, and participant comments.

During the initial phase, the research team members analyzed the quantitative data collected from the questionnaire, participant comments, and observations made during the experiment, considering relevant scientific literature. The outcome was presented in a list outlining strengths, weaknesses, and key observations. In the second phase, building upon the analysis of the list, the team formulated five lessons learned by consolidating similar findings and eliminating those needing more consensus. This process underwent a single iteration, as the researchers unanimously agreed regarding the proposed actions. In the final phase, the lessons learned were validated for feasibility and originality by three researchers external to the team and specialized in teaching and technology.

Through this collaborative effort, the lessons were refined and validated, resulting in a set of five improved learned lessons.

**Lesson 1**: *Perceptions of Ease and Adaptation*

The study reveals that teachers had generally positive perceptions of ease when interacting with VR technology. However, the variability in their responses suggests that while some found it extremely easy, others faced challenges or initial reservations. This underlines the importance of tailored training and support to ensure smooth adoption. This lesson confirms in part the insights provided by [22], who notes that, concerning the educational context, the majority of empirical studies analyzed between 1999 and 2009 (33 in total) were conducted in schools and colleges. He further anticipates that in the subsequent decade, virtual reality would have evolved into a mature technology suitable for pedagogical use. Overall, the literature review suggests that teacher perceptions of VR integration in learning can vary depending on their level of comfort with technology and their understanding of the potential benefits and challenges of using 3D IVWs for instruction [71].

**Lesson 2**: *Strong Belief in the Educational Impact of VR*

Teachers demonstrated a strong belief that VR technology could significantly enhance the learning experience for students, both in the classroom and at home. They perceived VR as a means to stimulate students' interest, increase their attention, and make educational activities more enjoyable. This aligns with numerous studies in the literature, highlighting that, regardless of learning outcomes, the added value of VR lies in the sense of engagement during use [19,20], and the intrinsic motivation evident in assessment tests [21]. Despite this, in [23] the author cautions to the contrary, noting that students' concentration during learning with a new immersive device might have adverse effects on attention. Additionally, in [23,72] they underscore that some users may experience discomfort and poor tolerance of the headset during initial use, and this can affect negatively the learning process. Finally, in [73], the authors suggest that for IVR to have a positive impact on teaching, preparatory courses on this technology should be provided to the students themselves.

**Lesson 3**: *Inclusivity and Access Considerations*

Participants recognized VR's potential to promote inclusivity by minimizing student differences within controlled virtual environments. However, they also acknowledged the need for policies and resources to ensure equal technological access, especially for economically disadvantaged students. This is further supported by [74], who emphasize the need for schools and students to equip themselves with a powerful and expensive computer to use applications in IVR. Nevertheless, recent technological advancements, as highlighted in the introduction of this work, have led to the proliferation of sufficiently powerful, standalone IVR devices at a reasonable cost, making them potentially viable tools for education.

**Lesson 4**: *VR for Prevention and Empathy Building*

Teachers highlighted VR's potential to address issues like bullying by simulating real-life scenarios and fostering student empathy. This suggests that VR can be a valuable tool for addressing social and behavioral challenges in educational settings. These considerations are further supported by the literature [75,76] that explores research on bullying, experimenting with simulated environments with young students to enhance their empathy and reduce bullying-related behaviors. However, while these studies provide intriguing insights, there is still a lack of longitudinal research to substantiate them.

**Lesson 5**: *Teacher Competencies and Training*

The study revealed that some teachers expressed concerns about their competencies in subject matter and VR technology. Comprehensive training programs are essential to maximize the benefits of VR in the classroom. Teachers should be equipped with technical expertise and the confidence to use VR effectively to ensure its successful integration. This aspect becomes particularly relevant when considering the challenges faced during the distance learning imposed by the COVID-19 pandemic emergency. As demonstrated by [77], teachers had to swiftly adapt independently to a new teaching methodology, and many were ill-prepared, lacking familiarity with information and communication technologies. Moreover, Murray in [78] suggests even more regarding the practical implementation of VR in regular education: teachers might opt to craft their own learning experiences in VR, and this implies the need to train teachers in acquiring skills such as scenario building, design, drawing, modeling, and programming.

These learned lessons offer insights into the acceptance and intentions of Italian teachers regarding the use of VR in education. They highlight the need for tailored training, inclusive policies, and support systems to harness VR technology's full potential in enhancing students' educational experience.

## 4. Conclusions

In this study, we conducted a hands-on workshop to explore three VR applications for educational purposes. Specifically, these applications encompassed distance learning, immersive 360-degree video experiences, and situated language learning. Our participants included 120 educators from various grade levels and academic disciplines within the Italian school system, all voluntarily participating in the workshop. Most of these participants had no prior experience with VR but displayed a keen interest in experimenting with and exploring its potential applications.

Utilizing a combination of surveys, participant observation, and the collection of feedback, our study has allowed us to distill five key takeaways. These takeaways illuminate the significant enthusiasm for VR across numerous educational disciplines, emphasizing its potential to enhance student learning. However, they also highlight certain reservations expressed by educators, which may pose challenges to the widespread adoption of VR. These reservations encompass factors such as budgetary constraints related to acquiring VR devices and the limited VR-related competencies or knowledge among teachers.

Our findings underscore the considerable interest in VR technology within various educational domains, suggesting its potential as a powerful tool for student development. Nevertheless, addressing the identified concerns, such as funding and teacher proficiency, will be pivotal in facilitating the successful integration of VR into educational practices. Addressing these concerns through targeted training and purposeful curriculum design will enable a more seamless integration of VR into educational practices, ultimately enriching students' learning experiences and expanding the possibilities for immersive and experiential education.

While this study provides insights into the acceptability of VR for educational purposes among high school teachers in Italy, it is limited in its scope, since the combination of cultural settings is almost infinite so that generalizing results is not always possible. In particular, there are several limitations that should be acknowledged:

Sample Size and Generalizability: The sample size of 120 high school teachers is relatively small, and they were primarily from a specific geographical region in Italy. This limits the generalizability of the findings to a broader population of educators. Future studies should aim to include a more diverse and representative sample.

Limited VR Applications: The study introduced teachers to three specific VR applications, which may not fully represent the wide range of potential educational VR tools and content. Different applications may yield varying results in terms of ease of use, student engagement, and perceived utility.

Questionnaire Uniformity and Specific App Assessment: One additional limitation of this study is the questionnaire used to gather data on teachers' perceptions of their experience during the educational VR workshop in three different experience scenarios. Despite their similar interaction and usage modalities, the questionnaire was uniform across the three VR applications. Consequently, the evaluation obtained from the questionnaire focused on a general assessment of the teacher experience, lacking a precise evaluation for each specific app in distinct learning scenarios. Future research should consider precise learning tasks for each specific VR application to be evaluated separately to measure their impact on learning in different settings.

Technology and Resource Constraints: The study acknowledges that cost is a significant barrier to the adoption of VR technology in educational settings. Additionally, access to the necessary hardware and software infrastructure may be limited in many schools. These resource constraints could impact the feasibility of widespread VR integration in Italian schools.

Short-Term Evaluation: The study involved a relatively short training session, and teachers' experiences with VR may evolve as they gain more experience and have the opportunity to develop more comprehensive lesson plans and strategies.

Evolution of VR Technology: The field of VR technology is rapidly evolving. The VR applications and hardware available at the time of this study may become outdated, and newer technologies may have emerged by the time of implementation in schools.

Despite these limitations, this study provides a valuable starting point for understanding the acceptability and potential challenges associated with integrating VR into educational practices in Italian high schools. Further research is needed to address these limitations and explore the long-term impact of VR on teaching and learning.

In the near future, we will collaborate closely with educational institutions to conduct extended semester-long trials of VR applications. During this period, we will gather feedback and in-the-field observations from teachers and students. This extensive exploration aims to validate the findings from our initial study and place a greater emphasis on the perspectives of the students.

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