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Unlocking the potential of virtual reality in education: Insights from teachers and recommendations for integration

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Highlights

- The study reveals a positive consensus among teachers regarding the necessity and impact of VR in education.
- The adoption of VR in education is hindered by various challenges, including limited content availability, difficulties in content creation, and infrastructure constraints.
- The study recommends initiatives that foster collaboration, knowledge-sharing, and training programs tailored to address challenges and specific needs of the teachers.

Article Info: Research Article

Keywords: *VR Integration in Education, Teachers Perceptions, Challenges of VR, Benefits of VR, Virtual Reality.*

Abstract

The integration of Virtual Reality (VR) technologies into education holds immense promise. Virtual Reality has the potential of providing an immersive and interactive learning experience, thus allowing students to engage with educational content in a more meaningful way. As it can be customized and developed for different purposes, VR can be integrated into almost all the school subjects. However, it is marked by its unique set of obstacles or challenges such as high prices of the devices, lack of software, limited usability, lack of competence of teachers etc. This study is mainly centered on the research interest of understanding how teachers apply VR technologies in their educational practices. The study delves into the experiences of teachers who participated in a survey. The survey was administered between September 2023 and November 2023, to 103 teachers from diverse educational backgrounds. The results were analyzed by using SPSS and MAXQDA software. Through their responses, the key findings that shed light on the integration, benefits, and challenges of VR technologies in education are provided in the current study.

1. Introduction

Virtual Reality (VR) is a computer-generated simulation of a setting or experience that immerses its users in a three-dimensional, interactive, and often realistic environment (Lowood, 2023). With the use of specialized hardware, such as VR headsets, users are transported to a simulated world where they can interact with and manipulate their surroundings. VR intends to create a feeling of presence and realism. It encourages users to interact with the virtual world much like they would in the physical world.

According to Sherman and Craig (2003), there are four main features of a successful VR experience: (1) virtual world, (2) immersion, (3) sensory feedback, and (4) interactivity. *Virtual world* is an imaginary environment formed by collection of objects, and rules controlling these objects (Sherman & Craig, 2003). These objects often appear through an environment and provide images of three-dimensional (3D) scenes to allow the user to navigate, explore, and interact. *Immersion* can be defined as the feeling of being in an environment (Sherman & Craig, 2003). This term can be used in two ways: mental immersion and physical immersion. Mental immersion is the state of being deeply engaged, while physical means bodily entering

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an environment (Sherman & Craig, 2003). It makes the experience closer to reality by using computer aids. *Sensory feedback* is getting actual feedback and seeing the results of the users' action in the synthetic world (Sherman & Craig, 2003). VR technology creates an environment that mimics human perception, allowing users to move around and track their motion on the screen while also manipulating their position using VR equipment. In addition to audio and video, VR can also engage other senses like taste, smell, and touch to create an immersive experience. *Interactivity* is in the very heart of the VR technology. The users can interact with the objects as if they are in their physical environment (Sherman & Craig, 2003).

2. Literature Review

The VR technology has applications across various industries, including gaming, education, healthcare, and training, offering an innovative and immersive way for users to perceive and interact with digital content (Ibanez & Delgado-Kloos, 2018; Potkonjak et. al., 2016). The integration of VR technologies into education specifically holds immense promise for supporting the meaningful and long-term learning of the students. It provides various advantages that are unique to this technology. Firstly, VR is a very powerful technology that can transport students to virtual environments (Park & Kim, 2022). It might be hard and costly to physically move students from one location to another one for teaching a specific content or skill. However, VR exceeds the limits of time, place and high amounts of money for teaching the content, and makes it possible to be in the virtual version of the environment in question (Park & Kim, 2022). By decreasing the cost on time and money, it provides the students with the efficient option to learn the topics in a meaningful environment. Moreover, by visiting such places, it has the potential to create a more effective, memorable and impactful learning experience.

Secondly, it also gives the opportunity to discover and examine the items that cannot be brought to the classroom physically (Hsiao & Su, 2021). For example, it is impossible to bring extinct animals to the classroom for a science class. Yet, by VR technology it is quite possible to place the students in a virtual environment where they can observe and interact with these animals. Addition to that, it is also a good way of visiting places that are dangerous or impossible to be in the real life, such as planets like Mercury or Venus (Hsiao & Su, 2021).

Thirdly, it gives students a new perspective for engaging with their learning materials. This enables students to explore subjects in ways that go beyond the traditional classroom setting, which provides hands-on and immersive learning opportunities for them (Kinshuk et al., 2016). This potential generates considerable interest in using VR to enhance interactive educational practices as well.

Next, as it can be customized and developed for different purposes, VR can be integrated into almost all school subjects (Stojšić et al., 2019). This is an important feature of the technology as it shows that the devices and software are not specific to any subject, which ultimately decreases the cost and increases the availability of the technology for different subject teachers.

Last but not least, VR helps to get the attention of the students as it provides fun and interesting way of learning (Alba et. al., 2021). The technology, visuals, interactions and innovativeness of the VR technology increases the enthusiasm and motivation of the students to learn the topic.

However, integrating VR into education poses its own set of challenges. These include the high cost of devices, limited availability of suitable software, usability concerns, and the need for teachers to feel comfortable with the technology (Alalwan et al., 2020; Gkoumas & Izzouzi, 2023; Graeske & Sjöberg, 2021; Maas & Hughes, 2020; Mantovani et al., 2003; Pellas et al., 2021).

Despite the growing interest in VR's potential to transform learning environments, how teachers perceive and implement Virtual Reality (VR) technologies in their educational practices, remains an under-researched area. The gap in the literature lies in the limited understanding of the practical challenges and barriers teachers face, as well as the lack of insight into their experiences and collaborative practices with VR in diverse educational settings. That's why, this study is mainly centered on the research interest of understanding how teachers of different subject matters apply VR technologies in their educational practices and what kind of challenges they face. The study aims to explore the various dimensions of VR

integration in education, the teacher beliefs on the usage of VR in education, and the challenges the teachers encounter while attempting to use VR in their classrooms. The study will contribute to the literature by highlighting these practical challenges, providing evidence on the perceived necessity and impact of VR in education, and offering recommendations to support teachers in effectively integrating VR technologies into their teaching practices. Based on these objectives, the current study is trying to find answers to the following research questions:

1. How do teachers perceive the potential benefits and drawbacks of integrating Virtual Reality into their educational practices?
2. What are the primary challenges faced by teachers in the adoption and implementation of Virtual Reality technologies in the classroom?

3. Methodology

3.1. Research Design and Data Collection Tool

This study employed a survey research design (Creswell & Creswell, 2018) to investigate the integration of Virtual Reality (VR) in education, focusing on the experiences and perspectives of teachers. The primary data collection method utilized was an online questionnaire, which was designed to gather insights into various aspects of VR adoption in educational practices. The questionnaire was prepared by the authors of this paper. To check the clarity and comprehensibility of the questions, the questionnaire was piloted with 5 teachers of different subject matters. The necessary changes and improvements were conducted based on the feedback from the pilot study.

The questionnaire consisted of a combination of nine closed-ended questions and twenty three Likert-type scale questions to allow the participants to express their opinions on predefined topics as well as providing a quantitative measure for certain variables. Addition to that, there were some follow-up, open-ended questions to allow the participants express their ideas on their answers and provide further explanations if they preferred.

3.2. Data Collection

The online questionnaire was distributed to participants through a user-friendly pooling platform from September 2023 to November 2023. Participants were provided with clear instructions, and the survey was structured to cover a range of themes, including perceived benefits, challenges faced, and practical applications of VR in teaching. The use of closed-ended questions facilitated the collection of quantitative data, while open-ended questions allowed for a deeper understanding of participants' attitudes and experiences.

3.3. Study Group

The teachers who received the questionnaire to participate in the research were chosen by using purposeful sampling method (Creswell & Creswell, 2018). They all have participated in the Digital Teachers Project (DTP), a specialized teacher training program designed to enhance the knowledge and skills of primary and lower-secondary school teachers (Kaplan et. al., 2022). The DTP aims to empower the teachers to deliver more effective classes by using digital technologies as a leverage, and one module of the program covered how to use and integrate VR technologies into the educational practices. (Orhak, 2023). The training program spans a duration of 10 weeks. It allows participants to immerse in a comprehensive curriculum which is focused on the effective utilization of digital tools and VR technologies in educational settings (Kaplan et. al., 2022).

The participants who filled the questionnaire engaged a diverse and representative sample of 103 participants, all of whom are actively working teachers in public schools. In terms of gender distribution, the participants comprises 89 females and 14 males. The age of the participants differed from 25 to 60. Table 1 shows the age range of the participants.

Table 1.

Age range of the participants

Age Range	Frequency
25-29	5
30-34	16
35-39	29
40-44	29
45-49	18
50-54	5
55-59	1
Total	103

The participants teach at various educational levels, including both primary and lower-secondary school levels (see table 2). Besides, they are teachers of different subject matters such as science, math, English language, visual arts etc. Most of the teachers are primary school teachers (61%).

Table 2.

School types where the participants work.

School Type	Frequency
Primary School	63
Lower Secondary School	38
Upper Secondary School	2
Total	103

3.4. Data Analysis

Upon completion of the survey, descriptive statistics were used to summarize and present key quantitative findings from the closed-ended questions and scaled responses. Measures such as frequencies, percentages, and averages were utilized to provide a snapshot of participants' attitudes, perceptions, and experiences related to VR integration in their teaching practices. Key metrics, such as mean scores and standard deviations, were employed to offer a clearer understanding of the central tendencies and variations within the dataset. IBM's SPSS Statistics Version 28.0.0.0 Package for MacOS was utilized to analyze the data and create tables and graphs.

Addition to the descriptive statistics, a qualitative analysis was conducted on responses to open-ended questions. By using the MAXQDA 2022 software, these open-ended responses were systematically coded and categorized to identify recurring themes, patterns, and nuanced insights. This qualitative analysis aimed to provide a deeper understanding of participants' perspectives, and more information on their experiences with VR in education.

4. Results

The first item in the questionnaire asked the participants to decide whether they thought using Virtual Reality in education was necessary or not. The quantitative analysis showed that all the research participants indicated that using VR technology in education was necessary without any doubt. Besides, a follow up open-ended question was asked to let the participants inform the researchers why they thought VR was or

was not necessary. For example, one of the participants, T-68, stated that "*Virtual reality is a very important educational tool because it can be used in all sciences and social sciences and because it removes space limitations in disadvantaged regions*". Another participant, T-70, indicated that *"Visiting places that are impossible to visit or see with virtual reality glasses attracts the attention of students. Using the enjoyable aspects of technology makes lessons attractive. For example, visiting Anıtkabir, traveling on Mars, etc. It made my students very happy"*. A bit over the quarter of the participants agreed with T-68 and T-70 that the VR technologies is necessary because they help to embody the abstract concepts by providing the chance of hands-on learning, and eliminate the time and place limitations especially in the disadvantageous areas.

Addition to that, fourteen of the participants also stated that VR makes the classes more enjoyable, interesting and leads to more permanent learning as it is a contemporary technology that attracts the attention of the students of the technology era. Lastly, few participants stated that VR was necessary in education but the population of classrooms and lack of materials or tools prevented them from using it.

Besides, all the participants acknowledged that using VR in education positively effected students' learning and motivation. In other words, they believed that when they used VR technologies in their educational practices, the students' motivations increased, and they learnt better. According to the follow up open-ended questions, the participants were of the opinion that the innovativeness of the technology and its appealing aspects increased the excitement and curiosity of the students, and led to high motivation. Interestingly, one of the participants stated that she created bond with one of her students who was too addicted to the technology that he lost his social skills and interest in the people around him.

The second question in the survey asked the participants how often they used the VR technologies in their educational practices. Some of the participants indicated that they used the VR technologies regularly (n=13, 12.7%). A good number of the participants (n=41, 40.2%) stated that they often used the VR in their classes. Table 3 shows the VR usage frequency of the research participants.

Table 3.

Frequency of using VR in educational practices.

	Frequency	Percent
Regularly	13	12.7%
Often	41	40.2%
Sometimes	35	34.4%
Never	13	12.7%
Total	102	100%

A follow up open-ended question was asked to let the participants inform the researchers how they used the VR technologies. A few of the participants stated that they used VR for preparing contents and products for different projects such as E-Twinning, Teknofest and Harezmi. Also, they used the technology in different subjects such as math, science, social sciences, English etc.

To exemplify, T-87 indicated that "*We had prepared a virtual informative environment about the Svalbard global seed repository. The students watched the video, then created an environment similar to what they watched and put information bubbles in it. For the 'Animals' unit, students prepared a zoo-style place. They watched a VR video about London and had a virtual tour in London, then answered questions about the video. During our e-Twinning project, the Ukraine-Russia war broke out. Students from all countries prepared anti-war banners using CoSpaces.*"

The research participants were trained on the usage of some specific tools and software, and provided with the VR cardboards and software access key in the scope of the Digital Teachers Project (DTP). The third question in the survey asked the participants how often the teachers used those tools and software in their classes. Figure 1 shows the results in a snapshot. The numbers in the figure show the frequency of the answers.

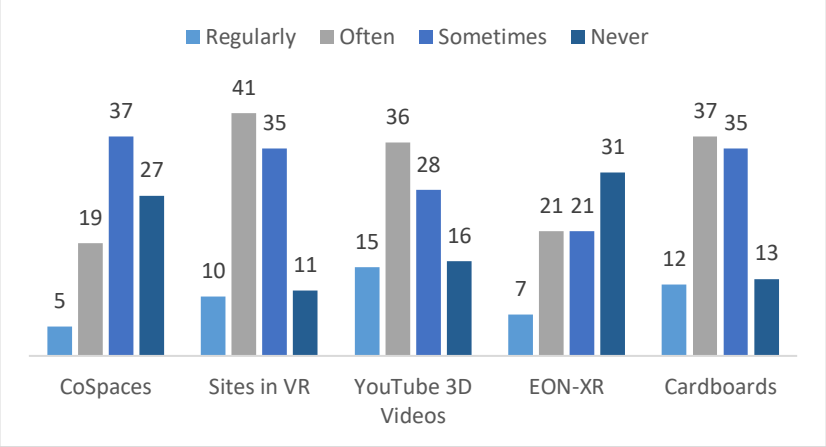

Figure 1 The frequency of using VR tools and software

The follow up question revealed that the participants used the technologies for different subjects and aims. As it was expressed by T-71, "*I use YouTube 360 a lot for games. I also use the 3D spaces application in virtual museum trips.*", the most common usage was for cultural visits to cities, museums, exhibitions etc. However, the participants also indicated the reasons that prevented them from using the VR technologies frequently. A few participants mentioned that the crowded classrooms, the lack of devices on the students' side, and the cost of VR headsets were the main reasons for not using the technology effectively. For example, T-81 stated that "*We had difficulty using the glasses. Since there were primary school children, it was difficult to employ a phone for each. There are 35 students in the class and it took a lot of time just with my phone*."

Addition to the follow up open-ended question above, one of the items in the questionnaire asked the participants the reasons for not using the VR technologies and knowledge in their teaching practices sufficiently. The participants were given with some options and asked to decide on the importance of the factor given. The results are given in Table 4.

Table 4.

The importance of factors for not using VR sufficiently in education.

	Frequencies		
	Very Important	Important	Not Important
The software used is not in Turkish language.	18	27	30
The software used is not appropriate for Turkish educational system.	14	28	32
The software used is not cost-free.	46	36	2
The software is not easy to use.	23	38	17
The given VR training was insufficient.	6	26	42
The distributed VR goggles were insufficient.	8	29	37
VR technologies is not appropriate for the course I teach.	11	35	32
I am not able to create VR content appropriate for the courses I teach.	26	36	16

The follow up open-ended question asked the participants to state the other reasons for not using the VR technologies in their classrooms. Besides the factors given above, due to the fact that the distributed goggles were cardboards and required a smart phone for the usage, the lack of infrastructure such as smart mobile phones were mentioned by 35% of the participants who answered this question. Additionally, the participants did not have sufficient in-class time or the classrooms were too crowded that's why they did not have a lot of chance to use the VR technologies in their educational practices. One of the participants, T-7, summarized the opinions of the other participants by stating that:

> "*In order to use these cardboards in class, students need to bring their own phones and install mobile applications. Our classes are generally 34 people. If I wanted to do this application, I could experience great chaos. I had my 8th graders take virtual museum tours in the last week of school, when only a few people came to class, of course they liked it very much. I also used it in my special education class this year to introduce the human body to a 6th grade student ... We were disappointed that the application was not in Turkish and that the phones froze or moved slowly while the application was open. We could not make clear eye movements with glasses. These practices cannot be performed in very crowded groups. Especially the phone is very problematic. We do not want them to use the phone in the school environment. There is also the situation of dropping the phone and breaking it, etc. ... I could not use these cardboards very productively."*

Addition to the frequency of the usage and the factors for not using VR sufficiently, the participants were also asked to indicate how and where they used these tools and software. More than half of the participants (56%) stated that they used them during the in-class activities. Two of the participants indicated that they used them for both in-class and out-of-class activities. The rest of the participants employed the tools and software for out-of-class activities.

Another item in the questionnaire asked the participants if they worked in collaboration with their colleagues to use the virtual reality technologies in their teaching practices. Only 24.8% of the participants (n=25) asserted that they did so. However, majority of the participants (n=75, 75.2%) did not collaborate with their colleagues to integrate VR in education. The follow up question asked the participants to indicate the reasons for not collaborating. Majority of the participants stated that their colleagues did not want to work together because of lack of their interest, motivation and knowledge. Addition to that, some participants stated that they did not have time or appropriate infrastructure to collaborate with the co-workers. For example, T-88 stated that "*Virtual Reality technologies are applications that require both glasses and a phone. At the same time, for example, EON-XR and 3D Spaces may not work on every phone. It takes time to introduce the application and explain how to use the glasses. Since we have a lot of work done at school and we are limited in time, I usually convey applications in my own classroom only"*. Nevertheless, some participants stated that although they did not have chance to work together with their colleagues, they shared their cardboards with them to provide them with the opportunity to do their own research and use the technology in their classrooms.

As to the last quantitative question, the last item in the questionnaire asked the participants to self-evaluate themselves for the given statements. There were four statements trying to gather data on the skills, knowledge and needs of the teachers on the usage or integration of VR in their educational practices. Majority of the research participants were of the opinion that they did not have sufficient knowledge and skills to prepare educational VR content and integrate VR in their educational practices. They indicated that they needed further training and support for developing their skills and educational practices. The results can be seen in the Table 5.

Table 5.

Self-evaluation of skills and knowledge.

	Frequencies		
	Agree	Neither agree or disagree	Disagree
I believe that I have the sufficient knowledge and skills to prepare educational contents by using the VR technologies.	36	45	20
I believe that I need training to prepare educational contents by using the VR technologies.	65	21	15
I believe that I have sufficient knowledge to integrate VR technologies in my educational practices.	37	41	21
I believe that I need training on the methods of integrating VR technologies in my educational practices.	56	28	18

5. Discussion

The results of the survey shed light on various aspects of teachers' perceptions and practices regarding the integration of Virtual Reality (VR) technologies into education. The study focused on understanding how

teachers apply VR technologies in their educational practices, by trying to explore different dimensions of VR integration, teachers' beliefs, and challenges they encountered.

5.1. The Usage of VR in Education

Many of the research participants have integrated VR technologies into their teaching practices at least for a few times. Moreover, 26% of the participants worked collaboratively with their colleagues to integrate VR in education. Teachers have used the power of VR for diverse educational activities, including e-Twinning projects, cultural visits, 3D city tours, museum exploration, and even watching experiments.

5.2. Perceived Necessity and Impact of VR in Education

All the research participants indicate that using VR in education is necessary without any doubt. They recognize VR as a means to embody abstract concepts, catch up with the requirements of the new era, and provide students with opportunities to apply their knowledge. As it was mentioned in the literature, VR technologies allow them to exceed physical boundaries (Park & Kim, 2022), visit distant places (Hsiao & Su, 2021), and engage students in fun and immersive learning experiences (Alba et. al., 2021). This finding enhances our understanding and perception on the fact that VR opens doors to explore items that are otherwise inaccessible and cultivates a deeper awareness of the world around us.

5.3. Collaboration among Teachers

Collaboration among teachers in integrating VR into education was found to be relatively low, with only a quarter of participants reporting collaborative efforts with colleagues. The primary reasons for this limited collaboration included colleagues' lack of interest, motivation, and knowledge, alongside significant time and infrastructure constraints. This finding underscores the necessity for initiatives that foster collaboration and knowledge-sharing among educators, enabling them to leverage the collective potential of VR integration in education. By addressing these barriers, we can promote a more cohesive and effective adoption of VR technologies in the classroom.

5.4. Self-Evaluation of Skills and Knowledge

The self-evaluation of teachers regarding their skills and knowledge related to VR usage revealed a nuanced perspective. While a significant number believed they possessed sufficient knowledge and skills, a considerable portion expressed the need for training, both in content preparation and the integration of VR technologies into educational practices. This self-awareness highlights an openness among teachers to continuous learning and professional development in the integration of VR in their educational practices.

5.5. Challenges and Barriers

Despite its potential, positive perceptions and considerable usage, the adoption of VR in education faces barriers. Teachers cited reasons such as limited content availability, difficulties in content creation, lack of parental and managerial support, infrastructure constraints such as the lack of mobile devices on the students' side, and challenges arising from external factors such as lockdowns as a result of natural disasters, and socio-economic disparities. Most of these findings were mentioned in the literature 20 years ago, by Mantovani (2003). However, even with today's technology and rapidly growing industrialization, the concerns are still mentioned by the users of VR.

As it was mentioned by Alalwan et. al. (2020), Gkoumas and Izzouzi (2023), and Graeske and Sjöberg, (2021), the paid subscriptions of the appropriate software to create VR content was found to be the most important factor of not using the VR in educational practices. Additionally, the participants also expressed challenges related to insufficient training, inadequate distribution of VR goggles, and limitations in creating VR content for specific courses. These barriers underscore the importance of addressing practical and logistical issues to facilitate smoother integration of VR technologies into education.

6. Implications and Suggestions

This study provides valuable insights into the current landscape of VR integration in education, highlighting positive perceptions, practical usage, and challenges faced by teachers. By addressing these challenges and fostering a collaborative and supportive environment, the educational community can harness the full potential of VR technologies, offering students a more engaging and immersive learning experience.

The study's findings have several implications for education. Firstly, the overwhelmingly positive perception of VR's necessity and impact suggests that targeted training programs should be designed to empower teachers further. Such programs could focus on addressing specific challenges identified, including content creation, software usage, and overcoming infrastructure limitations.

Secondly, collaborative initiatives among educators should be encouraged to create platforms for knowledge exchange and joint exploration of VR applications in diverse subjects. This can foster a community of practice where teachers collectively contribute to overcoming challenges and maximizing the benefits of VR in education.

Lastly, to enhance the integration of VR technologies, it is crucial to address practical barriers such as cost, software accessibility, and the availability of devices. This might involve initiatives from educational institutions, policymakers, and technology providers to support teachers in overcoming these challenges.

As for the suggestions for the future research, we are of the opinion that future research should focus on longitudinal studies to assess the long-term impact of VR integration on student learning outcomes and engagement across various subjects and educational levels. Additionally, investigations into the development and accessibility of cost-effective VR content and devices are essential to address the financial and infrastructural barriers identified in this study. Research could also explore effective training programs and collaborative frameworks that empower teachers with the necessary skills and knowledge to create and implement VR content. Moreover, comparative studies across different cultural and socio-economic contexts could provide deeper insights into the diverse challenges and opportunities in VR adoption in education globally. Last but not least, as there is a tremendous improvement and acceleration in the field of Artificial Intelligence (AI), the application and integration of AI tools into educational VR content and VR technologies should be investigated throughout the future research.

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