

## The Future of Virtual Reality and Education

**Kamil Bartu Feridun**

*PhD Student, Girne American University, Faculty of Communication, Communication and Media Management. Kyrenia/TRNC  
bartu.feridun@gmail.com*

**Ümmü Bayraktar**

*Assoc. Prof. Dr., Girne American University, Faculty of Communication, Department of Public Relations. Kyrenia/TRNC  
ummubayraktar@gau.edu.tr  
Orcid: 0000-0002-7415-5035.*

### Abstract

In today's world, technology plays a significant role in shaping our daily interactions and how we connect with the world. The rapid advancements in technology have influenced many sectors, particularly education, where integrating technology is now seen as essential rather than just a luxury. As a result, the education field has adapted over time to keep up with innovations and their potential to improve the teaching and learning environment. The incorporation of technology into education has evolved from introducing computer systems in classrooms to the adoption of smartboards, tablets, and e-learning platforms.

The rise of Virtual Reality (VR) technology has also opened up possibilities for hands-on learning experiences that allow students to explore and practice skills in ways that traditional teaching methods cannot. VR technology enables students to interact with content in a way that fosters a sense of presence and immersion, which can improve knowledge retention. In fields, like science, engineering, medicine, arts, and language learning, VR applications have shown promise in boosting student engagement and enhancing skills within a controlled learning environment.

However, the widespread adoption of VR technology in education faces challenges. One significant obstacle is the cost of acquiring VR equipment and software which can strain budgets. Additionally, the availability of high-quality content for VR platforms poses a barrier for educators seeking to integrate VR into their teaching practices. This article delves into the use of Virtual Reality in education, and how VR can influence student learning outcomes in applications such as medicine, science, arts and language learning. Apart from the advantages of VR, the article also discusses the obstacles that are impeding the use of VR in education including concerns about costs, standardizing content and the necessity for training and support for educators.

As VR technology advances and becomes widely available, it stands ready to revolutionize the landscape by offering learning opportunities that were previously beyond imagination. Through this technology, education can introduce a world of possibilities that nurture curiosity, creativity and a lifelong enthusiasm for learning.

**Keywords:** Education, Technology Integration, E-learning, Virtual Reality (VR), Immersive-learning

### Introduction

With the fast advancement of technology in today's world, technology is becoming an ever-increasing part of education. Conventional teaching methods are gradually being replaced by new technologies. This shift is driven by the necessity to provide students the knowledge and skills for a modern society. Virtual Reality is among the most revolutionary innovations that will transform educational experiences in interactive and immersive learning settings.

The role of technology within education shouldn't be undervalued. It helps prepare students for a world where digital literacy will end up as critical as traditional literacy and numeracy abilities. From projectors to computers, educational technology has evolved its individualized learning capabilities over time. Consequently, learning has become more efficient with laptops, tablets and e-learning software.

Education fosters social growth through technology. Through technology, educators can create inclusive and adaptable learning environments. Virtual reality presents opportunities for bridging these gaps through hands on learning that can address socioeconomic and geographic barriers. For example, students in certain countries with limited educational recourses could gain access to high quality virtual simulations of assets, environments,

scenarios, and hardware equipment that would otherwise be unavailable. Making education more accessible via technology is essential for equality and preparing all students to thrive in a society.

VR integration in education also indicates the need to develop thinking and problem-solving skills. Students may increase their understanding and retention in a VR-enhanced classroom by participating in simulations that require students to apply knowledge to real-world scenarios. Moreover, virtual reality can encourage innovation and creativity by enabling students to explore concepts and ideas in a risk-free environment.

### **The Evolution of Technology in Education and the Integration of Virtual Reality Technology**

Within the past two centuries, the way educators utilize technology in classrooms has transformed the way we learn and teach. From simple tools such as slate boards, we're now using sophisticated mobile devices. Each new advance in technology has made teaching more effective and engaging. Classrooms started to use slate boards and chalkboards in the 19th century where students wrote on slate boards and could erase their work easily. Chalkboards allowed teachers to teach lessons to the whole classroom with written content (Monroe, 2013). The printing press brought textbooks and workbooks where textbooks taught the curriculum as a standard, while workbooks provided practice and homework to help students learn on their own (Eisenstein, 1980).

During the early 20th century overhead projectors were popular in classrooms, teachers projected information on screens creating dynamic presentations in which they could write and draw simultaneously (Saettler, 2004). The 1920s introduction of radio made distance learning possible. Educational radio programs air lessons to remote areas. This was particularly useful when students could not attend school in person. By the 1930s filmstrips and movies were being used in education. These visual aids made subjects real and helped students understand and retain information (Cuban, 1986).

In the 1950s television was widely used for education. Several educational TV programs featured visual content and instructional programming. This period also saw the widespread use of photocopiers, which made it possible to duplicate printed materials for students to use (Cuban, 1986). The 1960s witnessed the arrival of electronic calculators in educational institutions, these devices made quicker calculations and more complex problems possible, allowing teachers to pursue deeper mathematical concepts.

Computers entered schools in the 1980s. Desktop computers appeared in classrooms and usually in dedicated computer labs. These machines served for everything from word processing and data analysis to interactive educational software. In the 1990s, the innovation of the Internet and the World Wide Web opened up education to large quantities of online material and information. Email and online forums enabled students and teachers to communicate and collaborate across geographical barriers and created a global learning community (Leu et al., 2004).

During the late 90s and early 2000s, interactive whiteboards were introduced. These combined both traditional chalkboards and computers. These touch-sensitive screens allowed teachers to view and interact with digital content making lessons more engaging and interactive (Smith et al., 2005). The 2000s saw the rise of mobile devices like laptop computers and tablets which influenced education further. These portable computers enabled students to access information, complete assignments and collaborate with peers virtually anywhere. Educational apps and software offered individualized learning according to student needs (West, 2012). Although e-learning is widely acknowledged as an advanced and essential technology for education, Virtual Reality emerges as a technology that could revolutionize educational practices once more.

Virtual Reality technology involves creating environments that users can engage with using devices such as headsets or hand sensors. This technology aims to enrich user experiences by transporting them into worlds where they can interact with objects and explore scenarios. The concept of VR traces back to the 1950s with inventions like the Sensorama, which provided multi-sensory experiences. Over time advancements like Ivan Sutherlands' Head Mounted Display (HMD) in the 1960s and commercial products like Nintendos Virtual Boy in the 1990s paved the way for modern VR systems such as Oculus Quest, HTC Vive and PlayStation VR. These innovations have greatly enhanced the graphics quality, motion tracking capabilities and overall user experience of VR systems making them more accessible and expanding their applications beyond entertainment to fields, like education.

The advancement of VR technology has revolutionized how people interact with worlds, offering immersive experiences that blur the lines between real life and the digital realm. The evolution of human-computer interaction has shifted from input methods like keyboards and mice to natural and intuitive approaches, including motion capture, haptic feedback, eye tracking, gesture recognition and voice control. These advancements in VR

technology have paved the way for user interactions allowing individuals to engage with environments in ways that closely mimic real-world experiences (Katona, 2021; Rogers, 2022).

Virtual reality technology holds great potential across sectors such as tourism, education, entertainment, and healthcare. In tourism, VR can provide virtual travel experiences that enable users to explore destinations without being limited by time or physical boundaries (Lanier, 2019). In education, VR can enhance learning by offering experiences that help students grasp concepts and develop skills in a safe setting (Hudson, 2019; Cvetković, 2021). Furthermore, entertainment realms like gaming and movies have been transformed by the integration of VR technology into interactive and immersive storytelling experiences for users (Galvan, 2017).

Despite its advantages, VR technology also faces challenges that hinder its evolution. The challenges ahead involve limitations in hardware development, such as restricted field of view and refresh rates in headsets, advancements in posture tracking tools, the absence of more sophisticated tactile feedback in most devices and most VR devices still having a form factor that can be uncomfortable to wear for long sessions. Additionally, the lack of high-quality VR content is also keeping the adoption of VR systems in question for some sectors (Rogers, 2022).

The integration of VR technology into education began gaining momentum during the 1990s, initially being applied in fields like flight simulation and medical training (Satava, 1993). These early applications demonstrated VRs potential to offer engaging learning experiences tailored to students. With VR technology becoming more accessible it has found its way into many educational disciplines in modern education. By enabling students to engage with content through virtual environments, VR has the potential to increase interest levels, improve comprehension, and boost memory retention (Bailenson et al., 2008). Its unique capability to offer simulations and hands-on learning experiences distinguishes it from other teaching methods. Research has shown that VR can assist in understanding concepts acquiring knowledge and enhancing comprehension making it a valuable tool, for mastering subjects and refining practical skills (Merchant et al., 2014).

Virtual reality technology has attracted the attention of scholars in education settings with its ongoing advancements in information technology, which have sparked increased interest in utilizing VR for its visualization capabilities and interactive features (Ding & Li 2022). This set an emerging trend in modern education to integrate educational material into VR applications. According to Ding and Li (2022) among 80 research studies examined, 66% focused on the use of VR in education in fields such as engineering, science, physical education, art, and history. Researchers have utilized assessment techniques such as surveys and tests integrated into reality (VR) settings along with a combination of traditional and embedded evaluation methods. The majority of research studies have demonstrated the positive impact of incorporating VR into education, influencing students' behaviors, cognition and emotional attitudes which in turn affect their learning outcomes. For example, VR enables medical students to practice skills without limitations on resources (Jung et al., 2012) while also having the potential to enhance empathy among students for better patient care (Dyer et al., 2018).

In a study conducted by Graeske and Sj'berg (2021), findings indicated that although some students in Technical Programs and Electrical/Energy Programs had exposure to VR outside the classroom, regular usage was limited and mainly associated with gaming activities. Many students from both programs expressed optimism about the potential of using VR in educational settings to enhance their motivation for learning. In the Technical Program group, nearly half of the students anticipated an increase in motivation levels through VR integration while a few individuals in the Electrical and Energy Program were uncertain about how VR could impact their learning motivation (Graeske & Sj'berg 2021). Interestingly further survey sections revealed that even students in the Electrical and Energy Program acknowledged VRs' benefits for learning; a significant percentage expressed varying levels of motivation (Graeske & Sj'berg 2021). Additionally, all participants conveyed their interest in exploring opportunities utilizing VR technology such as tours and immersive experiences (Graeske & Sj'berg 2021).

The progress of technology, in the field of education has been a journey where each innovation builds on one to enhance learning experiences that are more interactive and tailored to individual needs. The introduction of VR as a tool marks a significant milestone in this evolution offering immersive learning experiences that have the potential to transform how students engage with academic content. As VR technology advances and becomes more accessible it is poised to shape the landscape of education.

### **Methodology**

A comprehensive literature review is performed in this article that synthesizes latest research on the integration and effect of Virtual Reality in educational settings. A comprehensive review of a variety of resources, academic

articles, publications along with reports have been carried out, looking at the state of VR in education nowadays and its possible future advances.

The selected literature is examined to figure out key information, results, and themes on VR integration in education, its present use cases, together with the hurdles as well as problems related to its adoption. The research follows a structured approach, starting with a historical background of technology, the characterization as well as critical components of VR technology, VR integration for education, and real-world VR applications that are used in modern education in areas of science, medicine, engineering, arts, and language. These VR applications' impact on student learning is investigated in the literature review process. The literature review also blends findings from several sources to make a comprehensive and balanced image of the current state as well as future prospects of VR in education, including its advantages and hurdles and barriers to VR adoption in education. This analysis informs the recommendations and conclusions concerning future research, policy as well as practice relating to VR in education.

## Current Applications of Virtual Reality in Education Science & Engineering

### Astronomy Education: Titans of Space

The use of VR in science and engineering has been one of the most widespread and advantageous implementations to education. This application lets students explore the solar system by driving in a spaceship or floating in space. Students can interact with virtual planets and moons, and explore astronomical scales and distances from a variety of perspectives (Titans of Space 2024). Through the virtual representation of the solar system, "Titans of Space" helps students retain astronomical concepts and the interactive nature of the application encourages students to actively engage with the content.

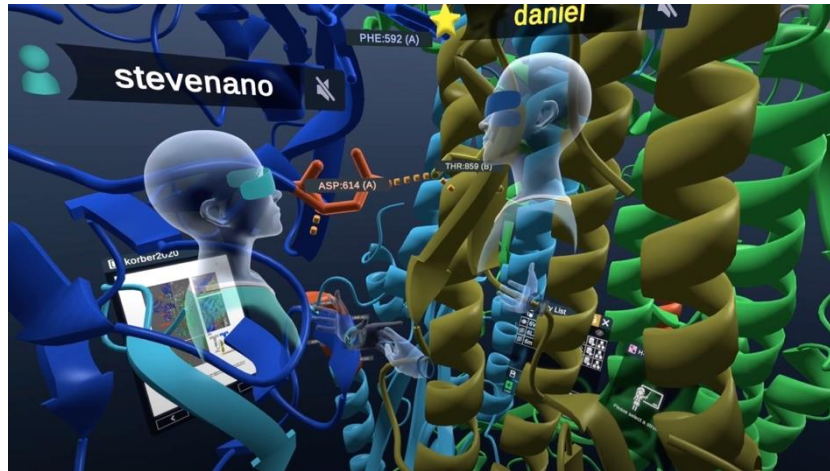


*Titans of Space.. [In-App Capture] Retrieved from <https://learnvr.org/portfolio/titans-of-space-2/>*

### Molecular Visualization: Nanome

In chemistry and biology, VR applications such as Nanome have changed the way students learn about molecular structures (Nanome, 2024). Nanome teaches students how to make and manipulate three-dimensional representations of substances, watch chemical reactions, and participate in biological systems at the molecular level. This hands-on approach to learning abstract concepts using visual and interactive media is effective in improving student comprehension (Nanome, 2024). Complex chemical and biological processes in a virtual environment may help students develop an intuitive understanding of the subject matter for improved learning outcomes.





*Nanome. [In-App Capture]. Retrieved from <https://nanome.ai>*

## Medical & Health Sciences

### Surgical Training: Touch Surgery

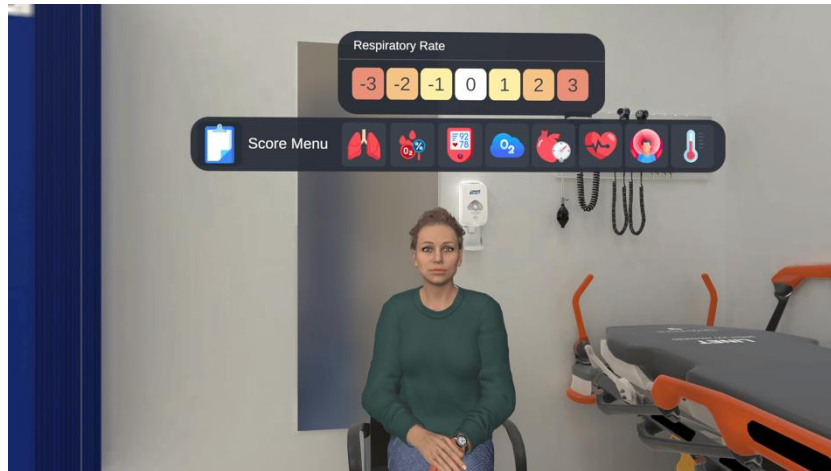
VR has also found its applications in medical and health sciences education, such as surgical training. Medical students can practice surgery in a virtual environment without real patients with the Touch Surgery application (Touch Surgery, 2024). With virtual surgeries, students can refine skills like hand-eye coordination and learn proper surgical techniques in a controlled and safe environment. This VR-based training approach gives students practical experience and confidence to perform real-life surgery. As a result, students trained with Touch Surgery have the potential to get better surgical performance and fewer errors than students receiving traditional training.



*DeepMind. (2021). [Screenshot from the video "AlphaFold Explained"]. YouTube. Retrieved from <https://www.youtube.com/watch?v=3tpnRFshvSA>*

### Patient Simulation: Medical Realities

Another VR platform is Medical Realities which offers immersive, interactive patient simulation experiences for medical and health sciences education (Medical Realities, 2024). By utilizing 360-degree video recordings of real surgical procedures and VR simulations of patient encounters, Medical Realities provides healthcare students and professionals with an environment to practice skills, increase knowledge retention, and foster clinical reasoning and decision-making (Samadbeik et al., 2018). Research indicates that the use of Medical Realities can improve surgical skills, confidence, and competence in medical and dental students (Sultan et al., 2019; Pulijala et al. (2018). As VR technology improves, platforms such as medical Realities will likely find their way into Medical and health sciences education to complement traditional teaching and prepare learners for real-world clinical practice.

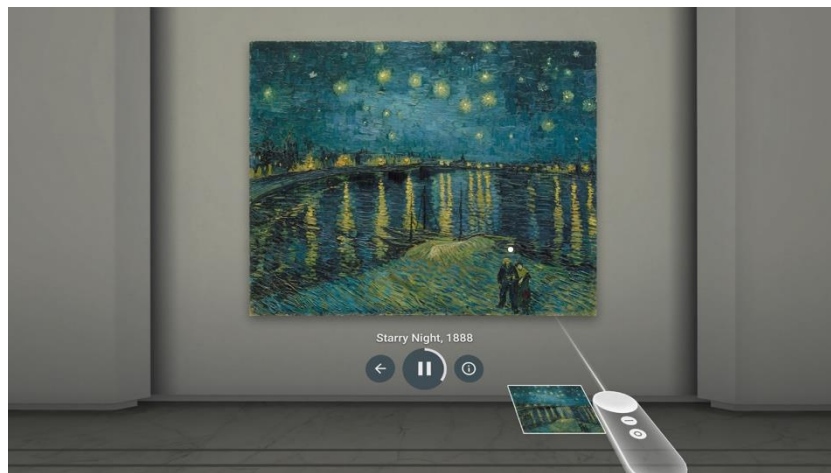


*Medical Realities. (2024). Virtual reality surgical training session [Image]. Retrieved from <https://www.medicalrealities.com>*

## Arts & Humanities

### Virtual Museum Tours: Google Arts & Culture

VR technology has also been utilized in arts and humanities education to enable students to go to historic sites, cultural artifacts, and museums in a virtual world. Google Arts & Culture is an example of using VR to deliver virtual tours of museums and art galleries worldwide (Google Arts & Culture, 2024). With this application, students can go to famous museums including the Louvre or the Museum of Modern Art, and see high-res artworks without needing to travel. This virtual access to cultural resources enriches art education and appreciation of various artistic traditions. By engaging with art and cultural heritage in a virtual setting, students can better understand the topic and historical context.



*Google (Screenshot of the Google Arts & Culture VR app interface). Google Play. Retrieved from [https://play.google.com/store/apps/details?id=com.google.vr.museums&hl=en\\_US](https://play.google.com/store/apps/details?id=com.google.vr.museums&hl=en_US)*

### Exploring Ancient History: Nefertari: Journey to Eternity

Nefertari: Journey to Eternity is a VR experience that students take a virtual tour of the ancient Egyptian queen's tomb (Nefertari: Journey to Eternity 2024). With this virtual application, students navigate the tomb, examine hieroglyphs and wall art, and find out about ancient Egyptian culture and beliefs. By bringing history to life through virtual reality, "Nefertari: Journey to Eternity offers students a chance to become involved in the subject in a more interactive and unforgettable manner. This VR experience may increase student interest and understanding of ancient history because it offers a perspective that traditional teaching methods lack.

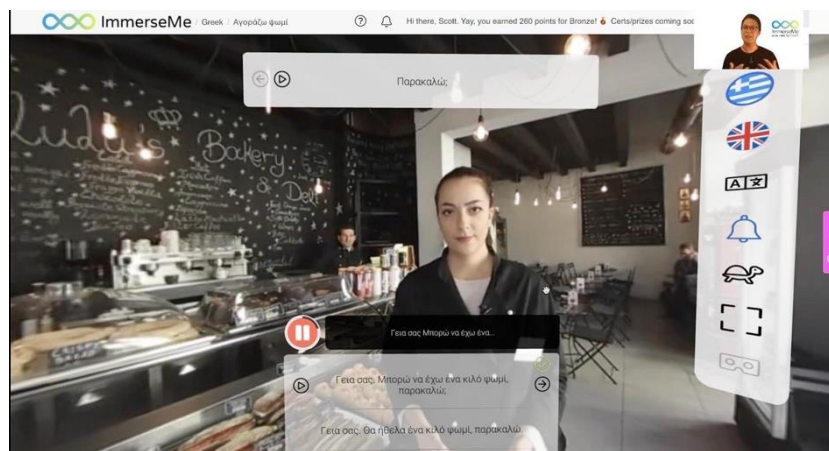


*Daily Mail. (2018). Virtual reality view of Queen Nefertari's tomb. Retrieved from <https://www.dailymail.co.uk/sciencetech/article-5935221/Step-inside-tomb-Queen-Nefertari-stunning-new-virtual-reality-experience.html>*

## Language Learning

### Immersive Language Practice: ImmerseMe

VR has also been used in language learning to create immersive situations that mimic real-life situations, allowing students to practice language in context. The "ImmerseMe" application allows language learners to have virtual conversations with native speakers in which students can practice their communication skills (ImmerseMe, 2024). Students can develop language proficiency in an authentic and interactive setting by talking, completing tasks, and exploring virtual environments with the target language. This immersive practice is shown to increase language learners' fluency, confidence, and cultural understanding.



*ImmerseMe. Screenshot from ImmerseMe VR Twitter account. Twitter. Retrieved from [https://twitter.com/immerseme\\_vr](https://twitter.com/immerseme_vr)*

### Virtual Language Scenarios: VirtualSpeech

Similarly, VirtualSpeech provides various virtual language scenarios in which learners can practice their language in simulated environments (VirtualSpeech, 2024). Students can participate in simulated job interviews, casual conversations, or business meetings in a virtual setting to overcome language barriers and prepare for real-world language use. Thus providing learners with appropriate contexts to practice language that may increase student engagement and motivation to improve language acquisition outcomes.





*VirtualSpeech. Microsoft AppSource. Retrieved from [https://appsource.microsoft.com/en-us/product/web-apps/virtualspeech1659518874468.virtualspeech\\_id?tab=overview](https://appsource.microsoft.com/en-us/product/web-apps/virtualspeech1659518874468.virtualspeech_id?tab=overview)*

## **Challenges and Roadblocks in Implementing Virtual Reality in Education**

### **Financial Constraints**

While VR offers many advantages for educational purposes, there are various obstacles delaying its widespread adoption. One major challenge is the cost associated with acquiring VR equipment and software, which is a burden that many educational institutions struggle to bear (Guttentag, 2010). The initial investment required for VR gear such as headsets and computing hardware can be substantial for schools operating on budgets. Furthermore, the ongoing expenses involved in maintaining and updating VR systems can further strain the resources of institutions.

### **Lack of Consistency and Educational Content**

Another significant issue is the lack of content in VR applications, leading to variations in the quality and effectiveness of VR-based learning experiences (Kavanagh et al., 2017). While there are plenty of VR applications, not all are developed based on pedagogical principles or aligned with educational curricula. Developing quality and educationally sound VR content requires collaboration among educators, subject matter experts, and VR developers. Without a shared framework or set standards for VR content, educators face challenges in choosing applications to incorporate into their teaching methodologies.

### **Technical Expertise, Training and Accessibility**

Some educators may encounter difficulties due to the technological knowledge and expertise needed to integrate VR technology into their teaching. As VR technology can be quite complex, educators will need guidance on how to set up, operate, and troubleshoot VR devices. They may also seek advice on incorporating VR into lessons and evaluating student progress in settings. It is crucial for educators to receive training and support to feel confident using VR technology in the classroom. Without training and assistance, educators might hesitate to embrace VR. Furthermore, Efforts should be made to address issues of fairness and accessibility so that all students have access to VR technology and resources. This could involve providing funding for VR equipment in schools or universities with budgets or developing VR applications for devices like smartphones.

### **Conclusion**

The incorporation of VR technology in education marks an advancement in the way teaching and learning are approached. As evidenced by the examples and studies outlined in this article, VRs unique capacity to offer immersive, interactive, and captivating learning experiences positions it as a game-changing tool for education. Whether it's allowing students to explore space, simulating medical procedures, or bringing historical events to life VR has the potential to transform how knowledge is shared and skills are developed in an increasingly tech-driven world.

Nevertheless, realizing the benefits of VR depends on collective efforts from all involved parties to tackle and overcome the various obstacles that are slowing down its widespread adoption. Major factors that play into these roadblocks are costs linked with VR hardware and software, the absence of standardization and quality assurance in VR content as well as the necessity for thorough training and support for educators (Guttentag, 2010; Kavanagh



et al., 2017). Overcoming these barriers will necessitate investments in VR infrastructure and content creation along with endeavors, among educators, researchers, and VR developers to ensure the development of pedagogically effective VR applications that align with established learning goals.

Furthermore, for VR to be effectively used in education educators must receive training and professional development to gain the skills and knowledge. This will empower them to integrate VR into their teaching methods. By equipping teachers with the tools needed to leverage VR technology, educational institutions can cultivate a culture of innovation that boosts student learning outcomes and readies them for society.

As VR technology advances and becomes more accessible it has the potential to level the playing field in education by providing learning experiences that were once limited by factors like location or socioeconomic status. This inclusivity can lead to an environment. Additionally, the flexibility of VR allows for tailored learning experiences that cater to student's needs and preferences promoting a learner-centered approach to education.

In regions with limited educational resources such as Northern Cyprus, integrating VR technology can offer students unique opportunities to explore virtual spaces, interact with virtual models of high-budget equipment, and virtually visit historical sites or museums from within their classrooms. By utilizing virtual reality technology, educators in Northern Cyprus could improve the quality and availability of education which can positively impact the social and economic development of the country. The virtual learning environments of classrooms offer endless possibilities for exploration, development, and success, by collective effort, it is possible to provide students the opportunity to engage with these revolutionary learning experiences.

### Future Prospects & Recommendations

- Governments and educational institutions should invest in VR technology infrastructure to make it more accessible for students. This investment can help alleviate barriers and expand VR learning experiences.
- Collaboration among educators, researchers, and VR developers is essential to create quality educational content that aligns with academic objectives and enhances student learning outcomes.
- Training programs should equip educators with the necessary skills to integrate VR into teaching practices effectively. These initiatives should cover aspects of VR usage as well as pedagogical strategies for enhancing student engagement and learning.
- Research on the effectiveness of VR in education is vital for informing the development of VR applications tailored to goals and student outcomes.
- In regions like Northern Cyprus, where educational resources are scarce, VR offers an opportunity for students to engage with virtual labs, 3D models, and historical sites or museums without leaving their classrooms. This innovative approach has the potential to enhance the educational system in Northern Cyprus, equipping students with skills needed for success in the economy of the 21st century.

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