VIRTUAL REALITY IN EDUCATION

Fundamentals, Devices, Applications and Innovation in Teaching

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Summary

Virtual Reality (VR) has stood out as an innovative tool in education, transforming the way students learn and teachers teach. The integration of VR devices, such as glasses and simulators, allows the creation of immersive environments, in which students can explore complex concepts in a practical and engaging way. Furthermore, VR offers opportunities for new teaching paradigms, such as virtual visits to museums, simulations of scientific experiments, and trips to historic places. This approach stimulates students' curiosity, creativity and engagement, making the learning process more dynamic and meaningful. Recent data indicates that schools and educational institutions are increasingly adopting VR as part of their pedagogical strategies, recognizing its potential for educational innovation. This work aims to demonstrate how Virtual Reality in Education is based on a promising area, capable of revolutionizing the way educators and students interact with knowledge.

Key words: Virtual reality. Innovation in Education. Innovation in Teaching. User Experience.

Abstract

Virtual Reality (VR) has stood out as an innovative tool in education, transforming the way students learn and teachers teach. The integration of VR devices, such as glasses and simulators, allows the creation of immersive environments, in which students can explore complex concepts in a practical and engaging way. Furthermore, VR offers opportunities for new teaching paradigms, such as virtual visits to museums, simulations of scientific experiments, and trips to historic places. This approach stimulates students' curiosity, creativity and engagement, making the learning process more dynamic and meaningful. Recent data indicates that schools and educational institutions are increasingly adopting VR as part of their pedagogical strategies, recognizing its potential for educational innovation. This work aims to demonstrate how Virtual Reality in Education is based on a promising area, capable of revolutionizing the way educators and students interact with knowledge.

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1. Introduction

1.1. Definition and History of Virtual Reality

Virtual Reality (VR or VR) is a technology that allows the creation of three-dimensional computer-generated environments, where users can interact in a realistic way, as if they were physically present in these environments. According to Burdea and Coiffet (2003), VR is defined as "the use of advanced interfaces and computer systems that enable the creation of interactive three-dimensional environments that simulate the user's physical presence". VR involves the use of devices such as virtual reality glasses, sensory gloves and other accessories that allow total immersion and interaction with the virtual environment.

In the 1980s and 1990s, VR began to gain more attention and investment, driven by advances in computer graphics and hardware. Companies like VPL Research, founded by Jaron Lanier, began developing and marketing VR equipment like the DataGlove and EyePhone. Lanier is often credited with popularizing the term "Virtual Reality". During this period, NASA also began exploring the use of VR for flight simulations and space training. Virtual Reality has emerged as a promising technology with applications in diverse fields, including military training, medical simulation and entertainment (RHEINGOLD, 1991).

As technology advanced in the early 21st century, VR became more accessible and effective. The development of devices like the Oculus Rift, launched in 2012 after a successful Kickstarter campaign, marked a significant turning point in the history of VR. Since then, companies such as Facebook (which acquired Oculus VR), HTC, Sony and Valve have invested heavily in the development of VR technologies, expanding their applications in areas such as gaming, education, healthcare and professional training. From Ivan Sutherland's earliest attempts to modern devices like the Meta Quest 2, the history of VR is marked by continuous innovation and growing recognition of its potential to transform the way we interact with the digital world.

1.2. Virtual Reality Technologies and Devices

Virtual Reality (VR) is powered by a variety of technologies and devices that work together to create immersive and interactive experiences. Among the main components are head-mounted displays (HMDs), such as the Oculus Rift and HTC Vive, which display three-dimensional images directly in front of the user's eyes.

These devices have motion sensors that track head movements, allowing the visual perspective to change as the user moves, creating a sense of presence in the virtual environment. In addition to HMDs, motion controllers such as the Oculus Touch and HTC Vive controllers allow users to interact with the virtual environment intuitively by tracking the position and movement of their hands for a more natural and immersive interaction.

In addition to HMDs and motion controllers, there are also additional accessories that enhance the VR experience. Haptic gloves provide haptic feedback, allowing users to feel textures and resistances of virtual objects, while full body tracking systems capture entire body movements for an even more immersive experience. 3D audio belts and force feedback devices are other examples of technologies that enrich sensory immersion by allowing users to see, hear and feel the virtual environment. As these technologies continue to evolve, the trend is for VR to become increasingly integrated into diverse fields, from entertainment to education and professional training.

1.3. Virtual Reality Working Principles

Virtual Reality (VR) creates simulated three-dimensional environments, allowing for realistic interactions. Immersion, or the feeling of being physically present in a virtual world, is a fundamental principle of VR. This is achieved through devices such as head-mounted displays (HMDs), which use high-resolution graphics and fast refresh rates to reduce latency and prevent discomfort. Slater and Sanchez-Vives (2016) describe immersion as "a state in which the user's perception is predominantly within the virtual environment, excluding external stimuli".

Another crucial principle is interactivity, which allows users to interact naturally and intuitively with the virtual environment. Motion controllers and sensors capture head, hand and body movements, reflecting users' actions in real time. Jerald (2015) states that interaction must be intuitive and direct to guarantee an immersive experience without interruptions. VR technology must respond quickly to users' actions while maintaining a high refresh rate to ensure a fluid and realistic experience.

Sensory perception is also essential in VR. In addition to sight and sound, VR can incorporate haptic feedback and other sensory stimuli to create a more complete experience. Devices such as haptic gloves and force feedback systems allow users to feel textures and resistance of virtual objects, increasing the sense of presence and realism. Burdea and Coiffet (2003) highlight that "VR is a multisensory medium,

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and the more senses are involved, the more immersive and realistic it will be." Integrating different sensory stimuli harmoniously is key to creating VR environments that look and feel real.

2. Virtual Reality in Education

2.1. Evolution of the Use of Virtual Reality in Education

Virtual Reality has experienced significant evolution from its first uses to its more recent and sophisticated integration in the field of education. The development of this technology and its pedagogical application reflect a growing recognition of its potential to transform teaching and learning. The earliest uses of VR in education date back to the 1980s and 1990s, when the technology was still in its early stages of development. At that time, educational applications were limited due to the high cost and complexity of the equipment required. Early implementations focused primarily on training simulations in fields such as aviation and medicine, where VR offered a safe and controlled way to practice critical skills. As noted by Psotka (1995): "early VR systems were predominantly used in professional training environments, where the benefits of safe and repetitive practice were evident."

With technological advances at the turn of the millennium, VR has become more accessible and practical for educational use. Miniaturization of components, improved graphics capabilities and reduced costs have contributed to wider adoption. In the 2000s, educational institutions began exploring VR for a variety of applications, from scientific simulations to virtual tours of historic sites. According to Dalgarno and Lee (2010), "VR has evolved to include a wider range of educational uses, offering immersive learning experiences that were previously unobtainable." In more recent years, VR has begun to be integrated more systematically into school and university curricula. Educators and educational content developers have been working together to create learning experiences that use VR to complement and enrich traditional teaching. Studies indicate that VR can significantly improve knowledge retention and understanding of complex concepts. For example, research conducted by Merchant et al. (2014) showed that "VR-based learning environments can lead to better learning outcomes compared to traditional teaching methods".

One of the most promising emerging areas is the use of VR to promote inclusive education. VR can be adapted to meet the needs of diverse

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students, including those with disabilities. VR tools can create personalized learning environments that help overcome physical and cognitive barriers. According to Smith and Hamilton (2015), "VR offers unique opportunities to make education more accessible and inclusive, allowing all students to participate in meaningful learning experiences." The future of VR in education looks promising, with continued technological advances and a growing body of research supporting its effectiveness. The integration of VR with other emerging technologies, such as artificial intelligence and the internet of things, promises to create even more sophisticated and effective learning environments. VR is expected to become an essential part of the educational ecosystem, providing learning experiences that are personalized, immersive and highly interactive.

The evolution of the use of Virtual Reality in education is a journey marked by technological innovations and a growing recognition of their transformative potential. From its first uses in training simulations to its current integration into school curriculum, VR has demonstrated its ability to enrich the learning experience, making it more engaging, inclusive and effective. As technology continues to advance, VR is likely to play an increasingly central role in education, shaping the future of teaching and learning.

2.2. Pedagogical Benefits of Virtual Reality

Virtual Reality (VR) has proven to be a powerful pedagogical tool, transforming the way teaching and learning are conducted. The immersion, interactivity and simulation capabilities provided by VR create a dynamic and engaging educational environment, facilitating students' understanding and retention of knowledge. Immersion allows students to feel part of the content they are studying, increasing engagement and motivation. According to Cheng and Tsai (2019), "the immersion offered by VR significantly improves student engagement, which can lead to better knowledge retention and a greater understanding of the concepts presented".

VR facilitates experiential learning, where students learn by doing. VR simulations allow students to practice skills in a safe and controlled environment. For example, medical students can perform virtual surgeries, while engineering students can test constructions in simulated environments. According to Makransky et al. (2020), "VR simulations offer unique opportunities to practice skills without the risks associated with real-world situations, improving students' confidence and competence."

VR technology offers opportunities to personalize learning, meeting the individual needs of each student. VR also allows you to adapt the pace and difficulty level of the content according to the student's progress, helping to cater to different learning styles and ensuring that all students reach their maximum potential. Radianti et al. (2020) highlight that "the ability to personalize educational content in VR can result in a more effective and satisfying learning experience for students".

VR also allows students to access environments and experiences that would be inaccessible or impractical in the real world, such as virtual visits to historic sites, exploration of remote ecosystems, or even trips to space. These experiences broaden students' horizons and enrich the school curriculum. VR allows students to experience situations that would be impossible to experience otherwise, offering a rich and varied context for learning (DALGARNO and LEE, 2010).

Furthermore, VR can improve collaboration and interaction between students. VR environments can be configured to support multiple users, allowing students to work together on projects, discuss concepts, and solve problems collaboratively. As noted by Roussou (2004), "VR facilitates real-time collaboration between students, creating a cooperative learning environment where ideas can be shared and developed together". As technology continues to evolve, its impact on education is likely to become even more significant, providing new opportunities to innovate and enrich teaching.

2.3. Challenges and Limitations of Implementing Virtual Reality

Virtual Reality has demonstrated enormous potential to transform education, offering immersive and interactive experiences that can enrich the learning process. However, implementing VR in educational environments faces significant challenges, such as the high costs associated with the technology. High-quality VR devices and the costs of developing and maintaining educational content may be unaffordable for many schools, especially in regions with limited resources (RADIANTI et al., 2020).

In addition to costs, the infrastructure needed to support VR is a major hurdle. Effectively implementing VR requires powerful computers, high-speed internet connections, and a suitable physical environment. Many schools and universities may not have the technical resources or infrastructure necessary to efficiently integrate VR into the curriculum (MERCHANT et al., 2014).

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For VR to be effective in education, it is crucial that teachers are adequately trained to use and integrate the technology into their teaching practices. However, many educators may not have the necessary training or feel insecure about using advanced technologies. The lack of training and ongoing support for teachers is one of the main obstacles to the effective implementation of VR in education (LUO et al., 2021).

While VR offers many advantages, it also presents a learning curve for students. Some students may have difficulty adapting to using VR devices and navigating virtual environments. It is important that VR experiences are intuitive and accessible for all students, including those with special needs (SMITH; HAMILTON, 2015). Furthermore, creating high-quality educational content for VR is a complex and expensive process that requires collaboration between technology developers and educators (DALGARNO and LEE, 2010).

Prolonged use of VR can have negative effects on the health and well-being of some users, including eye fatigue, nausea and spatial disorientation. It is crucial that VR implementations consider these factors and include guidelines for safe use of the technology. Ongoing maintenance of VR devices and updating software are practical challenges that educational institutions must address to ensure technology remains up-to-date and functional. Addressing these challenges effectively is essential for VR to realize its full potential as a transformative pedagogical tool (RADIANTI et al., 2020).

3. Applications of Virtual Reality in Different Disciplines

3.1. Virtual Reality in Science Teaching

Virtual Reality (VR) has emerged as a revolutionary tool in science teaching, offering immersive and interactive experiences that transform the way students learn and understand scientific concepts. The ability to simulate complex environments and phenomena provides significant pedagogical benefits, making abstract concepts more tangible and understandable. For example, students can explore molecules in three dimensions, observe chemical reactions up close, and travel through the human body to understand biological processes, thereby improving learning (MERCHANT et al., 2014).

VR makes it possible to create virtual laboratories where students can perform experiments that would be impossible or dangerous in a traditional classroom. These simulations provide a safe platform to practice experimental skills and

investigations without the risk of accidents or waste of materials. Makransky et al. (2020) state that "VR laboratory simulations allow students to perform experiments repeatedly, learning from mistakes." This saves resources and gives students the opportunity to experiment and learn in a controlled environment.

Additionally, VR allows students to explore environments that are inaccessible in real life, such as outer space, the ocean floor, or distant ecosystems. These immersive experiences increase students' interest and motivation, providing a richer and more contextualized understanding of the topics studied. Dalgarno and Lee (2010) note that "the ability to take students to distant and unexplored places through VR can significantly expand the reach of science education, making learning more engaging and memorable."

VR also promotes collaborative learning, allowing multiple students to interact in the same virtual environment. They can work together on science projects, perform group experiments, and discuss their observations and conclusions in real time. As noted by Roussou (2004), "VR facilitates collaboration and interaction between students, creating opportunities for teamwork and the development of communicative skills". This collaborative approach enriches the learning process by encouraging students to share ideas and solve problems together.

In this way, VR can contribute to more inclusive and accessible education in science teaching. Students with different learning styles or special needs can benefit from personalized learning environments that meet their individual needs. Smith and Hamilton (2015) state that "VR offers opportunities to make science education more accessible to all students, regardless of their abilities or limitations." Thus, VR has the potential to transform science teaching, making learning more immersive, interactive and accessible, and significantly improving students' understanding and retention of knowledge.

3.2. Virtual Reality in the Arts and Humanities

Virtual Reality (VR) has proven to be an innovative and transformative tool in the Arts and Humanities, offering new ways of experiencing, teaching and learning about culture, history and art. This technology provides immersive experiences that facilitate a deeper connection with the content studied, expanding creative possibilities and enriching the understanding and appreciation of the arts.

One of the main advantages of VR is the creation of immersive and interactive experiences in the historical and artistic field. Virtual museums, art exhibitions, and re-creations of period events allow users to explore and interact with content in new and engaging ways. According to Roussou (2004), "VR offers a unique platform for the interactive exploration of art and culture, allowing users to engage in deeper and more meaningful ways". These virtual environments make learning more engaging and memorable by allowing visitors to walk through galleries, examine works of art in detail, and participate in interactive activities.

VR facilitates more active and participatory learning in the field of Humanities. Instead of just reading about a literary work or a philosophical theory, students can explore virtual environments that contextualize this knowledge. For example, a literature class can be complemented with a virtual visit to the setting described in a novel, enriching students' understanding. Luo et al. (2021) highlight that "VR promotes experiential learning that can lead to a deeper and more applied understanding of Humanities concepts".

Furthermore, VR increases accessibility to art and culture, allowing people from different parts of the world and with diverse abilities to access rich cultural experiences. Museums and cultural institutions can use VR to create virtual exhibitions accessible to everyone, democratizing access to art and culture. Smith and Hamilton (2015) state that "VR has the potential to democratize access to art and culture, making them accessible to a wider and more diverse audience". This is especially important for people with reduced mobility or living in remote areas, offering them the opportunity to fully participate in cultural experiences.

3.3. Virtual Reality in Technical and Professional Courses

Virtual Reality (VR) has established itself as an effective and innovative tool in technical and professional courses, offering practical simulations and immersive learning environments. VR's ability to create realistic, interactive scenarios allows students to develop practical skills efficiently and safely. According to Makransky et al. (2020), "VR simulations allow students to practice and repeat procedures until they feel confident in their skills, significantly improving practical competence".

One of the main advantages of VR is the possibility of carrying out practical simulations in a controlled environment, reducing risks and allowing training in complex tasks without serious consequences. This is particularly important in areas such as aviation, healthcare and manufacturing, where a mistake can be fatal. Luo et al. (2019) state that "the

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VR provides a safe training environment where students can experiment and learn from their mistakes without the risks associated with real-life situations."

Implementing VR in technical and professional courses can result in long-term cost savings. Using simulations instead of physical equipment reduces wear and tear and the need for expensive materials. Additionally, VR can democratize access to high-quality training, allowing students from remote areas or those with limited resources to access advanced educational experiences. Radianti et al. (2020) highlight that "VR offers an economical and accessible alternative to practical training, especially in areas where resources are scarce".

VR also allows for the personalization of learning, adapting training to students' individual needs and providing immediate feedback, helping them correct mistakes and continually improve their skills. According to Merchant et al. (2014), "the ability to personalize training and offer real-time feedback is one of the great advantages of VR, as it helps students progress more quickly and efficiently".

Virtual Reality is revolutionizing technical and professional courses, providing an effective platform for practical training and skills development. The ability to perform safe simulations, reduce costs, personalize learning and improve knowledge retention makes VR an indispensable tool in technical and professional education. As technology continues to evolve, its impact in these areas is expected to become even more significant, providing new opportunities for innovation and excellence in professional education.

4. Perception and Acceptance of Teachers and Students

4.1. Acceptance of Virtual Reality by Teachers

The acceptance of Virtual Reality (VR) by teachers is crucial for its successful implementation in the educational environment. Studies show that the adoption of VR depends on the willingness of educators to integrate new technologies into their pedagogical practices. According to Luo et al. (2019), "teachers' perception of the usefulness and ease of use of VR directly influences their intention to adopt this technology in the classroom". Teachers who recognize the pedagogical benefits of VR, such as increased student engagement and improved knowledge retention, are more inclined to use it.

However, the uptake of VR faces challenges, including the need for adequate training and technical support. Many teachers express concerns

about your ability to operate VR technology and integrate it into the curriculum. According to Merchant et al. (2014), "the lack of adequate training and ongoing technical support are significant barriers to the acceptance of VR by teachers". Therefore, it is essential that educational institutions invest in training programs to help educators develop the skills needed to use VR effectively.

Furthermore, teachers' acceptance of VR may be influenced by the perception of institutional support and available resources. When schools demonstrate a clear commitment to technological innovation and provide the necessary resources, including VR equipment and access to quality content, teachers are more motivated to adopt these technologies. Radianti et al. (2020) highlight that "institutional support is a critical factor for the acceptance and continued use of VR in education". By creating a supportive environment and providing necessary support, institutions can encourage teachers to explore and incorporate VR into their teaching practices, benefiting both educators and students.

4.2. Student Interest in Using Virtual Reality in Teaching

Student interest in using Virtual Reality (VR) in teaching has grown exponentially, driven by the technology's ability to create immersive and interactive experiences. According to Cheng and Tsai (2019), "VR offers a more engaging way to learn, increasing students' motivation and enthusiasm." The immersive nature of VR allows students to explore complex concepts in a practical and visual way, making learning more interesting and memorable, especially in subjects such as science, history and geography.

Students, often called "digital natives," are naturally inclined to adopt new technologies due to their familiarity with digital devices. A study by Merchant et al. (2014) revealed that "students feel more engaged and participatory with VR tools compared to traditional methods". This predisposition facilitates the integration of VR into the educational environment, as students are eager to explore new ways of learning that align with their everyday digital experiences.

Furthermore, VR can provide personalized learning, tailored to students' individual needs. Radianti et al. (2020) highlight that "VR can be adapted to provide learning experiences that meet students' individual preferences and capabilities, promoting a more inclusive and effective learning environment". This personalization is important to cater to different learning styles and promote educational inclusion. The use of VR in teaching not only awakens

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students' interest, but can also improve knowledge retention and practical application of learned concepts, better preparing them for future academic and professional challenges.

4.3. Impact of Virtual Reality on Classroom Dynamics

Virtual Reality (VR) transforms classroom dynamics, increasing student engagement and making learning more interesting and motivating. According to Cheng and Tsai (2019), "the immersion provided by VR significantly improves student engagement, leading to better knowledge retention and greater understanding of concepts". VR allows students to explore three-dimensional environments and interact with virtual objects, promoting deeper engagement in the educational process.

In addition to engagement, VR facilitates active and participatory learning. In a VR environment, students manipulate and experiment with content elements, promoting a "hands-on" approach that can be more effective than traditional methods. Makransky et al. (2020) state that "VR simulations allow students to practice skills in a safe and controlled environment, significantly improving practical learning". This type of active learning improves understanding of concepts and develops essential practical skills.

VR also promotes collaboration and interaction between students, creating a more cooperative learning environment. VR environments allow simultaneous participation by multiple users, facilitating collaborative activities and group discussions. Roussou (2004) notes that "VR can improve collaboration among students by creating a shared environment where they can work together to solve problems and accomplish tasks." This not only enriches classroom dynamics, but also develops essential social and teamwork skills. Thus, VR transforms the way students learn and interact, creating a more dynamic and effective learning environment.

5. Virtual Reality and Immersive Learning

5.1. Creating Immersive Learning Environments

The creation of immersive environments for teaching is one of the most impactful innovations provided by Virtual Reality (VR). These environments allow students to experience learning in deeply engaging ways,

immersing them in scenarios that replicate or simulate situations from the real or fictional world. This increases students' interest and makes complex concepts easier to understand and retain. Dalgarno and Lee (2010) state that "immersive learning environments provide rich, interactive contexts that can significantly improve learning by allowing students to actively explore and manipulate content".

One of the greatest benefits of immersive environments is their ability to provide experiential learning. Instead of passively learning, students can actively participate in educational experiences such as laboratory simulations, historical reenactments, or ecosystem explorations. This is useful in subjects that require practical and visual understanding, such as science, history, and the arts. Makransky et al. (2020) highlight that "VR simulations allow students to practice skills in a safe and controlled environment, significantly improving practical competence and confidence".

Additionally, immersive environments can be customized to meet students' individual needs, offering different levels of difficulty and learning styles. Radianti et al. (2020) note that "personalization of learning in VR environments can result in a more effective and satisfying learning experience, tailored to the specific needs of each student." This personalization is crucial for inclusive education, ensuring that all students can fully benefit from the educational experience.

Immersive environments also promote collaboration and interaction between students. In a virtual setting, students can work together to solve problems, complete group projects, and participate in collaborative activities regardless of their physical locations. Roussou (2004) emphasizes that "VR can facilitate collaboration by creating a shared space where students can interact and collaborate in real time". This ability to work together in a virtual environment can improve students' social and teamwork skills.

In summary, creating immersive teaching environments represents a powerful educational tool that can transform the way students learn and interact with knowledge, offering a rich, engaging and personalized learning experience.

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5.2. Impact of Immersion on Engagement and Knowledge Retention

The immersion provided by Virtual Reality (VR) has a profound impact on student engagement, positively influencing the way they engage

with educational content. Immersion creates an environment where students feel part of the setting, allowing for a stronger emotional and cognitive connection to the material. According to Cheng and Tsai (2019), "the immersion provided by VR significantly improves student engagement, which can lead to better knowledge retention and a greater understanding of the concepts presented". When students are immersed, they are more likely to actively participate in learning activities, increasing their motivation and interest in the content.

Immersion facilitates experiential learning, where students learn by doing rather than just passively receiving information. This active approach is crucial to knowledge retention as it allows students to directly apply what they learn in practical, realistic situations. According to Makransky et al. (2020), "VR simulations allow students to practice skills in a safe and controlled environment, which can significantly improve practical competence and confidence." The opportunity to experience and interact with content in a practical way increases the likelihood of retaining and applying knowledge.

VR ends up providing deeper and more meaningful learning, connecting theoretical concepts with real experiences. In a VR environment, students can explore marine ecosystems, observe interactions between species, and better understand ecology concepts. Merchant et al. (2014) state that "immersive learning environments can make abstract concepts more tangible and understandable, significantly improving student learning". Viewing and interacting with content in a realistic context helps solidify knowledge and facilitates the transfer of learning to real-world situations.

Lastly, immersion can increase knowledge retention by promoting students' greater emotional engagement with the material. When students are emotionally engaged, they are more likely to remember what they learned and find personal meaning in the content. Radianti et al. (2020) note that "emotional and cognitive immersion in VR environments can lead to longer-lasting knowledge retention and deeper understanding of topics studied." In short, the immersion provided by VR not only increases student engagement, but also improves knowledge retention, making the learning process more effective and meaningful.

5.3. Examples of Immersive Educational Experiences

Immersive educational experiences enabled by Virtual Reality (VR) are transforming the way students learn by providing opportunities

unique ways to explore concepts in a practical and engaging way. A striking example is the use of VR laboratory simulations in science classes. These simulations allow students to perform experiments in a safe and controlled virtual environment, without the risks and costs of traditional physical laboratories. Makransky et al. (2020) highlight that "VR simulations allow students to practice skills in a safe environment, improving practical competence and confidence". This is useful in areas such as chemistry and biology, where students can observe chemical reactions or dissect virtual organisms, gaining a deep understanding of scientific processes.

Another significant example is the recreation of historical events and cultural environments. Using VR, students can "travel through time" to visit historic sites, participate in important events, and interact with historical figures within a realistic virtual environment. This approach makes learning history more engaging and helps students develop a richer, more contextualized understanding of historical events. Martins (2018) demonstrates that "VR allows total immersion in historical environments, offering a unique and enriching perspective on the past". By walking the streets of ancient Rome or attending a meeting at the court of Louis XIV, students can experience history in a visceral and memorable way.

In addition to science and history, VR is being used to create immersive experiences in areas such as medicine and professional training. Medical students can perform surgeries on virtual patients, gaining critical skills without the risks associated with real procedures. This practice in a virtual environment allows future doctors to gain experience and confidence before entering the operating room. Luo et al. (2019) state that "VR provides a safe training environment where students can experiment and learn from their mistakes without serious consequences". Likewise, in professional training, VR simulates emergency situations, complex machine operations and other scenarios that require precision and skill. These immersive experiences improve student preparation, increasing knowledge retention and practical applicability of learning.

6. Development of Practical and Experimental Skills

6.1. Simulations and Virtual Laboratories

Virtual simulations and labs are revolutionizing education, providing students with hands-on, engaging learning experiences that were previously limited by resource, security, or logistical constraints. These virtual environments allow students to conduct experiments and observe phenomena in a

controlled and safe scenario, eliminating the risks associated with physical laboratories. According to Makransky et al. (2020), "VR simulations offer a safe platform for students to practice scientific skills and concepts without the danger of accidents or the cost of consumable materials." This is particularly advantageous in subjects such as chemistry, biology and physics, where students can manipulate dangerous substances or expensive equipment virtually.

In addition to providing a safe environment, virtual laboratories allow for greater repetition of experiments, fundamental for learning and in-depth understanding of scientific concepts. In a virtual laboratory, students can repeat experiments as many times as necessary to fully understand the process and results, something limited in physical laboratories due to time and resource constraints. According to Merchant et al. (2014), "the ability to repeatedly perform experiments in a virtual environment allows students to hone their skills and solidify their knowledge more effectively." This practical repetition is essential for the formation of solid skills, better preparing students for future applications in the real world.

Simulations and virtual laboratories are also used in other areas of study, such as medicine and engineering. Medical students can practice surgeries and procedures on virtual patients, gaining experience without the risks of real surgeries. Luo et al. (2019) states that "VR provides a training environment where students can make mistakes and learn from them without causing real harm, increasing their confidence and competence". In engineering, students can test designs and perform performance simulations of structures in a virtual environment before building physical prototypes. These virtual labs increase accessibility and safety, improve knowledge retention and practical application of learned concepts, preparing students for future challenges in their respective fields.

6.2. Virtual Reality in Training and Qualifications

Virtual Reality has established itself as an innovative tool for training in various sectors, providing an immersive learning environment that safely simulates real situations. VR allows trainees to practice skills in scenarios that faithfully replicate the real world, eliminating risks and reducing costs associated with traditional training. According to Radianti et al. (2020), "VR offers a safe platform for practicing complex skills, allowing activities to be carried out that would be impossible or dangerous to carry out in the real world".

In the healthcare sector, VR is widely used for training doctors, nurses and other healthcare professionals. Medical students can perform surgeries and clinical procedures on virtual patients, gaining hands-on experience without the risks associated with real procedures. This practice allows future doctors to develop confidence and skills before working in high-pressure situations. According to Stival et al. (2023), "the use of VR in medical education has shown promising results in improving students' technical skills and reducing clinical errors". VR provides an environment where errors can be corrected safely, promoting more effective learning.

In addition to healthcare, VR is used in industrial and military training, where the simulation of dangerous or complex scenarios is essential for the adequate preparation of professionals. In industry, workers can be trained to operate heavy machinery or respond to emergencies without risk of harm or personal injury. Oil rigs, for example, use VR to train operators on safety procedures. According to Buttussi and Chittaro (2018), "VR allows the creation of highly realistic training scenarios, which improve knowledge retention and better prepare workers for real situations". In the military sector, VR simulates combat operations and survival tactics, offering a realistic training experience that prepares soldiers for the battlefield. As pointed out by Jensen and Konradsen (2018), "VR has been effective in military training, providing an environment where soldiers can develop critical skills and improve team coordination."

6.3. Assessment of Practical Skills Through Virtual Reality

The assessment of practical skills through Virtual Reality (VR) has proven to be effective and innovative in various fields, such as medicine, engineering and education. VR creates realistic, interactive scenarios where students can demonstrate their skills in a safe and controlled environment. According to Kavanagh et al. (2017), "VR provides an immersive means to assess practical skills, allowing assessors to observe and measure student performance in simulated situations that replicate the real world". This is useful in areas where practice in a real environment may be risky or impractical due to time and resource constraints.

In medicine, VR is widely used to assess surgical and clinical skills. Medical students can perform procedures on virtual patients, allowing instructors to evaluate their dexterity, accuracy and decision-making in real time. A study by Seymour et al. (2002) showed that "VR simulators can be used to assess the technical competence of surgeons in training, with results

which correlate well with performance in real surgeries." This approach provides immediate feedback and allows instructors to identify areas in need of improvement, promoting continuous and effective learning.

In addition to medicine, VR is used in industrial and military training to assess practical skills in complex, high-risk scenarios. Heavy machinery operators can be assessed in VR simulators that replicate real working conditions, allowing for a detailed assessment of their operational and safety skills. According to Buttussi and Chittaro (2018), "VR assessment offers a safe and controlled platform where workers' skills can be tested and improved without the risks associated with live training." In the military sector, VR evaluates soldiers' preparedness and response in simulated combat situations, providing valuable feedback to improve the effectiveness of operations. Virtual Reality demonstrates its potential as a powerful tool for assessing practical skills, offering a safer, more economical and more effective approach than traditional methods.

7. Conclusion

Virtual Reality in education represents one of the most promising innovations in recent years, offering new possibilities for teaching and learning. The ability to create immersive and interactive environments allows students to explore content in a practical and engaging way, transforming abstract concepts into tangible experiences. As a result, VR is revolutionizing the educational landscape by providing engaging and effective learning experiences. This technology facilitates understanding and retention of knowledge, promoting deeper student engagement and encouraging active participation in the educational process.

The VR-driven teaching revolution is redefining traditional teaching methodologies. With VR, educators can implement innovative pedagogical approaches that go beyond the conventional classroom. Methods such as project-based learning, simulations, and virtual labs allow students to practice skills in safe, controlled environments, increasing confidence and competence. Medical students can perform surgeries on virtual patients, while future engineers can test prototypes in a virtual environment before physically building them. These methodologies not only enhance hands-on learning but also prepare students for real-world challenges more effectively.

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New educational paradigms emerging with the use of VR are transforming the way knowledge is transmitted and acquired. Personalization of learning is one of the main benefits of this technology, allowing teaching to be adapted to students' individual needs and rhythms. This is particularly important in a diverse educational context where skills and learning styles vary widely. Furthermore, VR facilitates the creation of collaborative learning experiences, where students can work together on projects, even if they are in different locations, promoting a sense of community and cooperation.

The great interest of teachers and students in VR technology in education is a clear indicator of its transformative potential. Teachers who adopt VR report greater student motivation and engagement, as well as improved knowledge retention. Studies show that VR can increase teaching effectiveness by providing a more dynamic and interactive learning environment. Students, in turn, demonstrate enthusiasm and curiosity regarding new technologies, valuing the opportunity to learn in a more engaging and practical way. This growing interest suggests that VR has the potential to become an essential tool in the modern educational curriculum, establishing new paradigms that make learning more effective, engaging and personalized.

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