



VIRTUAL AND AUGMENTED REALITY: APPLICABILITY IN EDUCATION



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ABSTRACT

The objective of this research was to analyze the applicability of virtual reality (VR) and augmented reality (AR) in the educational context, investigating the possibilities of integrating these technologies into the teaching and learning process. The methodology

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adopted was of a bibliographic nature, with a survey of articles and academic publications in databases such as SciELO, Google Scholar and other relevant sources. The results indicated that both VR and AR offer great benefits for education, such as the creation of immersive and interactive environments, which favor student engagement and the personalization of learning. However, significant challenges were identified, such as the high cost of implementation, the need for teacher training, and the adaptation of the curriculum. The conclusion of the research points out that, despite the difficulties, these technologies have the potential to transform education, making learning more dynamic and accessible, but for this, it is essential to overcome structural obstacles and ensure adequate strategic planning for their effective implementation in schools.

Keywords: Education. Technologies. Virtual and augmented reality.

INTRODUCTION

Virtual reality (VR) and augmented reality (AR) are technologies that, although initially associated with entertainment and the digital entertainment industry, have shown great potential for transformation in several areas of knowledge. In recent years, these technologies have begun to gain ground in the educational field, promising new ways of learning and interaction. VR creates immersive digital environments that allow the user to interact with the virtual world in a sensory way, while AR overlays digital elements onto the real world, enriching the user's perception. Both technologies present a wide range of possibilities for teaching and learning, providing immersive and interactive experiences that can, in fact, change the way we teach and learn (Barbosa et al., 2018; Baldissarelli; Gomes; Hahn, 2024).

With the advancement of technologies and the increase in global connectivity, education has also been undergoing significant transformations. Traditional methodologies, which often limit learning to expository and unidirectional teaching models, have been questioned in the face of the need for greater interaction and personalization of the educational process. In this context, the use of innovative tools such as VR and AR emerges as an alternative to enrich the student experience and promote more active and engaging learning. These technologies allow the creation of dynamic and interactive environments, in which students can, for example, explore content in a deeper and more practical way, going beyond the limitations of time and space (Afonso et al., 2020).

The applicability of VR and AR in education covers a wide range of areas of knowledge, such as science, mathematics, history, geography, arts, and even in learning processes of practical skills. Virtual reality, by enabling the creation of fully digital worlds, can be used to simulate scientific experiments, space travel, historical events, and other contexts that would be impossible or too expensive to reproduce in the physical environment. Augmented reality, on the other hand, by integrating digital elements into the real environment, allows students to visualize abstract concepts in a concrete way, facilitating the understanding of complex content and favoring learning in a more intuitive way (Carvalho; Liato, 2020).

In addition, both VR and AR are tools that promote the personalization of learning, allowing students to advance at their own pace and tailor experiences according to their needs and interests. The interactivity provided by these technologies contributes to improving student engagement, making the learning process more playful and engaging. The use of these technologies can improve content retention, since they encourage hands-on learning and problem-solving in real or simulated contexts. However, despite the great

potential, the use of VR and AR in education also presents challenges (Franca; Silva, 2019).

The implementation of these technologies requires investments in infrastructure, teacher training and, in many cases, the adaptation of pedagogical content to new teaching formats. In addition, the effectiveness of VR and AR in education depends on how these technologies are integrated into the school curriculum and how educators use them to foster learning. It is essential that teaching methodologies are rethought in order to make the best use of these technological innovations, without losing sight of the pedagogical objectives (Leite, 2020).

Thus, the objective of the research was to analyze the applicability of virtual and augmented reality in the educational context, investigating how these technologies can be incorporated into the teaching and learning process, what are the benefits and limitations associated with their use, and how they can transform education. The research also seeks to understand the perspectives of educators on the use of these tools and identify the challenges that may arise during the implementation of these technologies in educational institutions.

This is a bibliographic research, which was carried out through the survey of articles and academic publications in databases such as SciELO, Google Scholar, among others. The literature review allowed a comprehensive analysis of the discussions and studies on the integration of virtual and augmented reality in education, offering a critical and grounded view on the possibilities and challenges of these technologies in the school environment. The research contributes to the understanding of the potentialities and limitations of VR and AR, pointing to future paths in the use of these technologies in teaching.

DEVELOPMENT

TRANSFORMATIVE POTENTIAL OF VIRTUAL AND AUGMENTED REALITY IN EDUCATION

The use of virtual and augmented reality in education can be considered a revolution in the paradigm of traditional teaching. Both technologies, while distinct in their form of interaction, have the power to create immersive and meaningful learning experiences. Virtual reality, by creating a fully immersive and simulated environment, can transport students to different contexts, such as a visit to an art museum or even a simulation of scientific experiments, such as diving to the bottom of the sea to study marine life. This type of approach allows for a more intense experience of the content, which tends to improve the understanding and retention of information (Carvalho; Liato, 2020).

On the other hand, augmented reality has the role of enriching the physical environment by superimposing digital elements on top of the observed reality. This can be observed in several areas of knowledge, such as in a biology class, where AR can show 3D models of human organs or cellular structures, allowing students to explore these structures in a more interactive and three-dimensional way. This possibility of seeing and interacting with abstract concepts in a visual way makes learning more concrete, facilitating the assimilation of complex information and favoring a greater understanding of the topics covered. These technologies offer a number of advantages over traditional teaching methods. They offer a more engaging and personalized learning experience, allowing the student to interact directly with the content (Afonso et al., 2020).

The interactivity promoted by VR and AR motivates students to delve deeper into the disciplines, exploring various aspects of learning in an active and practical way. In addition, by making it possible to adapt content to the pace and needs of each student, these technologies meet the different forms of learning, providing a more inclusive and diversified teaching. The use of VR and AR can also reduce the physical and temporal limitations of the school environment. Many educational contents, such as complex scientific experiments or historical journeys, can be simulated or visualized with a depth that would be impossible to accomplish in the physical world, either due to lack of resources or spatial limitations (Afonso et al., 2020).

In this sense, the use of these technologies promotes a significant expansion of the students' repertoire, allowing them to live experiences and learn in more innovative ways. However, the application of VR and AR in education is not without its challenges. One of the main obstacles is the cost involved in implementing these technologies in schools, especially in public institutions, which often face financial difficulties. Equipment such as virtual reality glasses and mobile devices for augmented reality are necessary, which implies considerable expenses, in addition to the need for training for teachers, who need to become familiar with the new pedagogical tools. This initial investment can be a limiting factor for the widespread adoption of these technologies (Carvalho; Liato, 2020).

Another challenge refers to the adaptation of the educational curriculum. Pedagogical content needs to be restructured to be compatible with the new forms of teaching provided by immersive technologies. This restructuring requires a deep reflection on teaching methodologies, in order to ensure that technologies are used effectively, without deviating from traditional educational objectives. For this, it is necessary to develop new teaching materials and the constant training of educators (Carvalho; Liato, 2020).

Finally, the implementation of these technologies in schools requires continuous support from public education policies, as well as collaboration between universities, technology companies, and schools themselves. The creation of an ecosystem favorable to educational innovation, with investments in infrastructure and professional training, is essential for the success of this transformation in education (Barbosa et al., 2018).

BENEFITS OF IMMERSIVE TECHNOLOGIES IN EDUCATION

The application of virtual and augmented reality in the educational context presents a number of benefits that can revolutionize the way students engage with academic content. One of the biggest benefits is the ability of these technologies to increase student engagement. When students can interact with the study material in a practical and dynamic way, rather than just listening to or reading about it, the level of interest and participation tends to increase considerably. For example, in a history lesson, a student can "travel back in time" and observe a historical event from within, actively participating in the narrative. This type of involvement contributes to the construction of more lasting memories and more meaningful learning (Afonso et al., 2020).

Another important benefit is the support for active learning. Virtual and augmented reality allow students to experience, simulate, and solve problems in a controlled environment, which favors learning by trial and error, without the risks and costs involved in a real environment. In fields such as medicine, for example, nursing or medical students can practice surgical procedures in virtual reality simulators, gaining hands-on experience without the need for a real patient. This reduces the risk of error and increases students' confidence in their abilities (Carvalho; Liato, 2020).

In addition, these technologies also contribute to the personalization of learning. Each student has a different learning pace and style, and both VR and AR can be adjusted to meet these differences. Students with learning disabilities can benefit from more visual and interactive experiences, while more advanced students can explore the content on a deeper, more autonomous level. This type of personalization promotes inclusion in the school environment, allowing all students to learn according to their needs (Costa; Oliveira, 2017; File; Domingues Junior; Gomes, 2023).

Another positive point of using VR and AR is the possibility of collaborative learning. While technologies are often seen as individual tools, they can be used collaboratively, creating group learning experiences. In virtual reality environments, for example, it is possible to create scenarios in which students can interact with each other, work together to solve problems, or even simulate situations that require cooperation, such as the

construction of a scientific project. This type of collaborative learning helps to develop teamwork and communication skills, which are fundamental for students' personal and professional development (Afonso et al., 2020).

In addition, these technologies can be used to expand access to knowledge. In places where educational infrastructure is limited, virtual and augmented reality can provide an alternative for carrying out educational experiences that would otherwise be inaccessible. For example, a school in a rural area can use VR to take its students on a virtual tour of an art museum or a national park, allowing these students to have access to high-quality educational content, regardless of their geographic location (Carvalho; Liato, 2020).

In addition, the use of these technologies in education can contribute to the formation of citizens who are more critical and prepared for the digital society. By interacting with immersive technologies, students develop technological skills essential for the job market of the future, in addition to learning to deal with new forms of communication and information. This preparation for the digital future is fundamental, as technology is increasingly present in all aspects of daily life (Lima; Domingues Junior; Silva, 2024; File; Silva; Domingues Júnior, 2024; Leite, 2020).

CHALLENGES AND LIMITATIONS OF IMPLEMENTING IMMERSIVE TECHNOLOGIES

Despite the many benefits that virtual reality and augmented reality can offer, their implementation in education faces considerable challenges that need to be overcome so that these technologies can be effectively integrated into the education system. The first major obstacle is the infrastructure needed to support these tools. For virtual reality to be used efficiently, for example, specific devices are needed, such as VR glasses and high-performance computers, which not all schools have. This high initial cost makes the adoption of these technologies a significant challenge, especially for public education institutions with limited budgets (Silva et al., 2011).

Additionally, teacher training is an essential factor in ensuring that immersive technologies are used effectively. Educators need to be trained not only to operate the devices, but also to integrate them into the curriculum in a pedagogical way. This involves restructuring teaching methodologies, with a focus on more active, interactive, and student-centered teaching practices. For this, it is necessary that teachers receive continuous support, through workshops, refresher courses and monitoring in the use of these new tools (Carvalho; Liato, 2020).

Another important challenge refers to the adaptation of pedagogical content to the format of immersive technologies. Often, the available courseware is not ready to be used interactively in VR or AR environments. The transformation of traditional books and texts into immersive experiences requires the creation of new educational resources, which requires time and investment. In addition, the integration of these technologies into the school curriculum needs to be carefully planned, so that the use of VR and AR does not become just an isolated activity, but an integral part of the teaching and learning process (García; Ortega; Zednik, 2017).

Resistance to change can also be a limiting factor. Many educators, students, and even parents may be accustomed to the traditional education system and may see the use of new technology as a threat or a challenge. Overcoming this resistance requires a change in mentality, which must be promoted not only by the school, but also by public education policies. The acceptance and engagement of teachers, students, and educational managers are essential for the implementation of immersive technologies to be successful (Afonso et al., 2020).

Finally, there are ethical and safety issues that need to be considered when introducing virtual and augmented reality in schools. Excessive exposure to technology, for example, can lead to health-related issues such as eye strain or physical discomfort. In addition, the collection and use of personal data during interaction with these technologies must be carefully regulated in order to protect the privacy of students and prevent the misuse of this information (France; Silva, 2019; Coast; Oliveira, 2017).

FINAL CONSIDERATIONS

The main objective of the research was to analyze the applicability of virtual reality (VR) and augmented reality (AR) in the educational context, investigating the possibilities of integrating these technologies into the teaching and learning process. From the literature review, it was possible to observe that both VR and AR offer a vast potential to transform pedagogical practices, creating a more interactive, engaging, and effective learning environment. Both technologies provide immersive experiences that allow students to experience abstract concepts in a concrete way, offering an innovative approach to disciplines that require greater visualization and interaction, such as science, mathematics, and history.

Research has shown that utilizing VR can create entirely new and enriching educational scenarios, where students are transported to digital worlds that allow for the simulation of experiences that would be physically impossible or difficult to accomplish in a

conventional classroom. Similarly, AR can add layers of information to the real world, expanding students' perception and understanding of the content studied, and providing a more dynamic and personalized learning experience.

In both technologies, interactivity is a key point, as it motivates the student to actively engage in the learning process, in contrast to more traditional and passive methods. However, despite the clear benefits, the research also identified significant challenges to the implementation of these technologies in schools. The cost of acquiring adequate equipment, the need for specialized training for teachers, adapting the curriculum, and resisting change are all obstacles that must be overcome if the integration of VR and AR is to become a reality on a large scale.

The lack of infrastructure in many schools, especially public ones, is one of the biggest impediments, making it essential that there are continuous investments in educational technologies and support for educational institutions. Another relevant point that the research addressed was the importance of a careful pedagogical approach in the use of these technologies. It is not enough just to provide technological equipment; it is essential that teaching methodologies are reformulated to explore the potential of these tools effectively, aligning immersive experiences with educational objectives and promoting the inclusion of different learning styles and rhythms.

Teachers play a central role in this process and need to be prepared not only to operate technologies, but to use them in a critical and pedagogical way. The research also concluded that VR and AR have great potential to expand learning opportunities, promoting a more personalized and inclusive education. These technologies offer a fertile field for the development of new didactic resources, but they also require constant care with the training of educators and the adaptation of teaching strategies.

In addition, it is necessary to consider the ethical and security issues involved in the use of these technologies, ensuring that the privacy of students is respected and that exposure to these tools is carried out in a balanced manner. In summary, the research showed that virtual reality and augmented reality have the potential to transform education, offering new forms of teaching and learning, but their effectiveness depends on overcoming several challenges, such as the necessary infrastructure, teacher training, and curricular adaptation. The successful integration of these technologies in education requires strategic planning, collaboration between different agents in the education sector, and public policies that encourage and sustain this transformation.

It is, therefore, a promising path, which, if well implemented, can mean a revolution in the way we teach and learn, with positive impacts for both students and educators. This

research was of a bibliographic nature, being carried out through the analysis of articles and academic publications in databases such as SciELO, Google Scholar, among others. The literature review allowed a critical and in-depth view of the benefits, challenges, and possibilities of using VR and AR in education, pointing to the need for a continuous commitment to educational innovation and overcoming the obstacles that still limit access to these technologies.

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