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The Effectiveness of Immersive Technologies for Future Professional Education

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Abstract: The research on the application of immersive technologies in education began relatively recently and the issue remains open. In order to modernize the learning process, educational simulators, simulators, and textbooks are being developed. Immersive technologies help to absolutely immerse in the learning process, interact with objects inaccessible in the usual reality, get used to acting in acute situations, and as a result - to improve the effectiveness of learning. The aim of the work is an empirical analysis of the methodological basis of the experience of using one of the artifacts and mercurial technologies - virtual reality. Despite the fact that virtual reality has recently been referred to ultra-modern technology, today virtual reality headsets are not a novelty of the technology, but mediators of knowledge. The use of virtual reality devices for immersive learning is becoming relevant and accessible. Methods - empirical research using systematic search, and comparative analysis of two pedagogical experiments involving artifacts. Results - it turned out that virtual reality seems to be as effective as previous technological tools used in education, and in certain specialties can contribute to better performance in learning. Practical significance - the results of the work may establish specific learning contexts in which virtual reality is more effective than others and may allow new educational

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opportunities, especially in shaky geopolitical situations. Virtual reality is a modular technology that adapts to all situations and allows the creation of extended learning materials. Nevertheless, it has proven to be more effective for certain specialties, such as the medical field.

Keywords: virtual reality, displays, training, efficiency.

Introduction

In recent years, immersive learning with assistive artifacts (Head Mounted Virtual Reality Display, HMD) has experienced unprecedented growth (El Miedany, 2019). HMD specifications have improved markedly over the past ten years, particularly concerning field of view, resolution, and frames per second.

Research Problem

The relevance of the contribution of this study is to formalize the connections between different methods of transferring and obtaining knowledge and to prove their effectiveness. Thus, the question of determining the level of knowledge allows us to establish the extent to which immersive learning involving artifacts is of interest for education in the context of the rapid development of technology. Virtual reality as a learning tool is often questioned, the same is true for video games and virtual reality. Mehrfard et al (2019), focus on the interest in using video games for learning through their ability to attract the attention of a new generation. A combination of behaviorist, cognitivist, and social constructivist approaches can be found in a synthesis of different pedagogical approaches (e.g., inductive pedagogy). Therefore, the use of artifacts in learning is controversial (Owens & Tanner, 2017). The authors appeal to the fact that the criteria for evaluating the effectiveness of artifacts in learning should be viewed exclusively from the perspective of behaviorist theory because we are talking about psychotactic practices. One of the markers of the effectiveness of immersive learning with the use of technology is the degree of perception and transfer of information, assessment of the students' ability to use the acquired knowledge in real life. According to Lytvynova et al. (2021), there are four factors that influence the degree of perception and transfer of information: accuracy of the virtual environment, immersion, presence, and user acceptance. The effectiveness of the devices also plays an important role.

Research Focus

Virtual reality is used in a variety of professional fields (from military to industrial). Virtual reality headsets are becoming available and interest in this technology is based on the ability to immerse the student, control, and simulate a virtual environment. In this process, educator guidance is very important to retain the student's attention and motivation. Boyles (2017) defines virtual reality as the scientific and technological domain of exploiting computational and behavioral interfaces to simulate in a virtual world the behavior of 3D entities interacting in real-time with each other and with one or more users in a pseudo-natural immersion through sensorimotor channels. In other words, virtual reality refers to an artificial computer-generated environment where the user is immersed in real-time. This immersion can be achieved with a head-mounted display or a special room with an immersive effect. In addition, this immersion includes visual as well as sound and tactile stimulation. The user is active and changes in the artificial environment depend on their interaction with it (Tang et al., 2022). The user's physical, sensory-motor actions lead to experiences in the artificial environment, offering stimuli in

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response to actions (feedbacks). That said, the mere use of an overhead display does not imply the content of virtual reality, which should be distinguished from augmented reality.

One of the first benefits of virtual reality in learning is that it increases student motivation. Researchers have concluded that virtual reality can have great benefits for learning. Virtual reality technologically creates a compelling set of experiences in real-time. The development of this technology began in 2012 and the first area of application was architecture, later design, and gradually, virtual reality has become part of the latest pedagogy.

In this context, compared the interest of students of the two learning formats, traditional and immersive, it turned out that the information presented through the immersive room aroused more interest of students mentioning the more interesting possibilities of interaction in CAVE™ and in particular with the teacher who gives explanations (Calderon et al., 2017).

Research Aim and Research Questions

These devices are now increasingly being integrated into education and vocational training in the industrial, medical, or military sectors. At the same time, scholars are still questioning its use in the educational process (Alotaibi, 2019). In this context, the purpose of this study is to investigate the relationship of immersive learning and its effectiveness. The paper aims to revise the empirical evidence for the learning effectiveness of a device such as virtual reality (VR) headset; formalize the theory of such learning; and to consistently present said artifact as an accessible element for evaluating learning effectiveness.

Research Methodology

The systematic search was conducted in the following databases: Elsevier, ERIC, ACM Digital Library, Springer, Taylor & Francis Group, and IEEE Xplore. First, we filtered articles like "reviews," "studies," "meta-analysis," and "systematic review," and then we conducted empirical studies.

The study is guided by the theory of learning – Chittaro (2016), which analyzes devices related to immersive learning, adhere to his tenets of the cognitive theory of learning using artifacts. This theory describes learners' cognitive processing of information through two main channels: visual and auditory. In addition, the author emphasizes the importance of motivation (from a cognitive perspective) in learning.

General Background

Since the issue of the use of virtual reality in education is still open and there are mostly review articles on the subject, rather than developed curricula, it was decided to compare two case studies conducted at different times by the authors (Huang et al., 2010; Ray & Deb, 2016).

Sample / Participants / Group

In their own experience, Huang et al. (2010) invited 68 students to use an engaging 3D interface to explore human organs. Students gave positive feedback on the 4 criteria evaluated: imagination, immersion, interaction, and cooperative learning. In the same dynamic, students were divided into two experimental groups (136 students total). Group A - 68 students worked with a virtual reality headset, with a sense of presence and immersion, Group B - 68 students used a traditional computer.

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Ray and Deb's (2016) experience is based on an experiment conducted among 100 biology students Group A (50 students) and Group B (50 students). Group A was offered virtual reality via Oculus Rift Development Kit 2 for better learning performance. Group B studied using traditional methods. The experiment lasted for 2 months, 2 sessions per week (a total of 16 sessions). During this period, Group A received verbal explanations from the conventional manuals, on the board, and using PowerPoint® (via projector), while Group B, in addition to similar verbal explanations, used the Oculus Rift Development Kit 2 to access 3D models instead of frozen images.

Instrument and Procedures

In the first experiment, group A used a helmet BP Z 800 3D Visor, which is able to work with different programs (as a second monitor) observing the standard requirements for the technical capabilities of the computer. The complex three-dimensional image can be achieved using the application in 3D packages, Maya. The head tracker has a resolution of 800x600 and refresh rate of 60 Hz and an angular size of 40 x 60 degrees. Working with Z 800 in front of the user appears a rectangular screen at a distance (like in a cinema), where the anatomical image of the internal organs is unfolded (Fig. 1).

Figure 1

BP Z 800 3D Visor Helmet

In the second experiment, Group A used the Oculus Rift Development Kit 2 glasses. The Oculus Rift Development Kit 2 has a Full HD OLED screen analog with 960×1080 resolution for each eye. This makes the image clear and contrasty, projecting the image within reach of the entire field of vision. Low response time (2 ms) and high refresh rate of the matrix (75 Hz) allow to get rid of blurring and jittering of the image during sharp movements, which is extremely important for research of tree slice layers (subject of the class), (Fig. 2).

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Figure 2

Glasses Oculus Rift Development Kit

Research Results

Virtual reality has been used for many years for training (piloting, driving, and surgery). However, there are big differences in the implementation of immersive learning: different device configurations, different types of knowledge to be acquired. This is why the experiments described have illuminated different learning efficiencies. (Huang et al., 2010; Ray & Deb, 2016) argue that virtual reality does not systematically guarantee better learning performance than traditional learning. However, the immersive opportunities that virtual reality offers have a positive impact on motivation and learning effectiveness.

The results of the experiment indicate the need to distinguish the typology of virtual reality use for learning. There is a need to develop a classification that is based on the nature and purpose of immersive learning and allows the effectiveness of the use of virtual reality. Because, depending on the specialty, immersive learning shows its strengths and weaknesses.

In the first experiment, virtual reality compensates for the lack of mediation, as medicine involves risky and expensive simulation training. Virtual reality for the medical specialty has been used for many years for training purposes because VR allows:

– avoid health risks to students (infection, injury, etc.)

- reduce training costs,

- make mistakes without serious consequences for the living patient;

- provide immediate feedback on decision-making and influence during training.

It turned out that the keen interest in virtual reality demonstrated by Group A is not news, because medical education, especially in surgery, has been using stereoscopy, a technique similar to the 3D cinema, consisting in the presentation of two flat images, for a relatively long time. In this context, virtual reality is certainly effective for medical specialties. In the experiment, the authors saw a significant difference in learning between the groups. Thus, for medicine, virtual reality is a pedagogical tool that

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takes its place in the training modules not as a simple addition to the "traditional" media, but as an independent multimodal approach.

For the second experiment, there was no significant difference between teaching with the help of "traditional" media and virtual reality. Of course, one cannot argue for the ineffectiveness of immersive learning with the inclusion of artifacts (virtual reality). Virtual reality in the second case rather showed equivalent effectiveness. Nevertheless, the authors positively assess virtual reality, appealing to the fact that the teacher can use virtual reality without the risk of reducing students' attention span. For the Biology major, virtual reality can be included as a special modality among others, allowing the teacher to modify their strategy and diversify their teaching tools. In this case, the "novelty" effect of virtual reality can also be positive and help motivate students and engage them in learning. The novelty effect has a positive effect on student motivation. However, according to the evaluation results, the authors observe no correlation between immersion and learning: no significant difference in learning between different groups was observed.

Thus, the use of virtual reality, particularly for simulations, would prove to be an effective knowledge mediation option for certain majors. The most productive is the use of virtual reality in the field of medicine. Virtual reality allows the simulation and execution of medical interventions that are too complex in a real-time environment. Consequently, the ability of students to represent intangible elements of representation using virtual reality guarantees an increase in the effectiveness of learning and acquired knowledge.

Discussion

Scholars are now treating immersive learning, a unique kind of immersive learning, as the most successful form of digital learning. This type of learning differs from other solutions in its novel and active approaches. According to Wang et al. (2017), the use of Serious Games and virtual reality to create a digital universe where the learner or employee develops in a reality environment is an invaluable asset of our time. Solidarize, because virtual simulation naturally finds its place among the methods most suited to certain professions or companies whose complex processes require on-the-job training or the "do no harm" principle. The advantages of immersive learning include the unconditional ease of implementing the educational process compared to traditional studies. The author also talks about the complete absence of risks for the learner, who can make mistakes without danger, such as medics in simulation centers. Until now, many approaches to learning have only been about offering methods developed according to pedagogical dogma. El Miedany (2019) suggests considering more stimulating training in the use of artifacts in learning. This would be an active means to acquire new knowledge more quickly and assimilate it quickly. In this context, scholars analyze active pedagogy as a digital tool to fully individualize learning (Peng, 2022). The authors see only positives in such learning, because there is no risk of mobilizing precious time for a student, for example, or for a company employee, to take a training course that covers the points he already possesses. Immersive learning offers real support and guarantees a perfect optimization of the learning process (Mallam et al., 2019).

In addition, adapting to such learning constitutes a certain amount of difficulty for the learner (student, company employee). For example, a company employee during immersive learning has to learn how to apply his knowledge before how the company works, but also in a short time to discover all the principles of the latter (Veziridis et al., 2017). Depending on what is expected of him, he will also have to learn new skills very quickly in order to be able to perform his role effectively. Having a tool

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within their reach that allows them to practice all the necessary gestures in an environment in every way similar to the one in which they will develop, allows them to approach this key stage with ease (Pears & Konstantinidis, 2021).

Contemporary educators Lie et al. (2022) describe the most interactive options for immersive learning (serious games, virtual or augmented reality, etc.) and analyze modules designed precisely for the purpose of positive assessment by students, as satisfaction with learning naturally leads to improved learning.

European scholars (Pears et al., 2020) appeal that the benefits of introducing virtual artifacts go much further. Those who recently condemned immersive approaches because of the alleged dehumanization of traditional teaching methods are now reconsidering their positions. As the health care crisis has underscored the importance of having reliable and engaging means to continue learning, even remotely or in isolation, digital learning is more relevant than ever. Saxena et al. (2018) emphasize that virtual learning platforms encourage their users to evolve and bring them closer together. In addition, they can move and interact in the same environment, communicate, collaborate, and live together, enriching experiences that allow them to better memorize the learning program (Peck et al., 2020). Nevertheless, immersive learning has its drawbacks: a place in a face-to-face environment, a substitute for live interaction, and material, geographic, and budgetary constraints (Binytska et.al., 2020).

One thing that is certain about "learning tomorrow" is that interest in interactive, virtual, and game-based formats is equally proportional to the needs of today's rapidly evolving technologies.

Conclusions and Implications

The effectiveness of immersive learning using artifacts (virtual reality) is considered. Encouraging empirical results on their use are noted, especially on students' attention and motivation. Attention and motivation turn out to be the mainstays of such learning. The use of virtual reality devices (headsets, helmets, glasses) is based on the interaction of students with the virtual and interpersonal environment. For modern pedagogy, proper preparation for the use of virtual devices is important, we are talking about a new dimension in science - immersive pedagogy, which is primarily focused on the student. Immersive learning is a challenge for educators and learners and therefore may come with setbacks, but the advantage of virtual learning is the "do no harm" principle, as in the field of medicine. A literature review of immersive pedagogical methods proves their usefulness for the education of the future. Some advances in neuroscience help to better understand which educational approaches encourage the neurobiological mechanisms associated with good learning. From a teaching and learning perspective, psychological and social issues need to be taken into account. Taking these factors into account when using virtual reality allows for better integration into the learning process in times of constraint (Covid, war). The transfer and acquisition of knowledge through virtual reality seems to be effective in many configurations. However, not all of these configurations have yet been fully explored. Furthermore, depending on the appropriate learning variation of virtual devices in terms of immersion, quality, and learner perception, their effectiveness remains mixed or immeasurable. However, together with the rapid market breakthrough of competitively priced virtual reality headsets and reasonably satisfactory technical performance, regardless of the scientific results about which there is consensus, their widespread use for learning purposes seems more likely than ever. However, the risks inherent in virtual reality headsets should be studied and considered: e.g., cyber-sickness and visual fatigue.

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Therefore, empirical research should be continued to provide evidence of the benefits and risks of these devices, especially with regard to human factors. In this way, it will be possible to take full advantage of the benefits of using virtual reality.

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