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PROSPECTS AND RISKS OF USING VIRTUAL REALITY TECHNOLOGIES IN EDUCATIONAL PROCESSES

Abstract: This study aims to assess the possibilities and limitations of VR technologies in the field of education, to develop recommendations for their qualitative and safe integration into the educational process. In addition, a comparative analysis of DVR and IVR, convenience and impact on human health, advantages and disadvantages are discussed. Recommendations are also made about guidelines for the use of VR by people with various diseases. Researches in this area are analyzed.

Keywords: virtual reality, DVR, IVR, simulator, virtual presence, VR in education, Vestibular, proprioceptive and visual data.

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ПЕРСПЕКТИВЫ И РИСКИ ИСПОЛЬЗОВАНИЯ ТЕХНОЛОГИЙ ВИРТУАЛЬНОЙ РЕАЛЬНОСТИ В ОБРАЗОВАТЕЛЬНЫХ ПРОЦЕССАХ

Аннотация: цель данного исследования — оценить возможности и ограничения технологий виртуальной реальности (VR) в сфере образования, а также разработать рекомендации по их качественной и безопасной

интеграции в образовательный процесс. Кроме того, проводится сравнительный анализ DVR и IVR, рассматриваются удобство использования и влияние на здоровье человека, преимущества и недостатки. Даны рекомендации по использованию VR людьми с различными заболеваниями. Проведен анализ исследований в данной области.

Ключевые слова: виртуальная реальность, DVR, IVR, симулятор, виртуальное присутствие, VR в образовании, вестибулярные, проприоцептивные и зрительные данные.

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TA’LIM JARAYONLARIDA VIRTUAL REALLIK TEXNOLOGIYALARIDAN FOYDALANISH ISTIQBOLLARI VA XAVFLARI

Annotatsiya: ushbu maqolada ta’lim sohasida virtual reallik (VR) texnologiyalarining imkoniyatlari va cheklovlarini baholash, ularni ta’lim jarayoniga sifatli va xavfsiz tarzda integratsiya qilish bo‘yicha tavsiyalar ishlab chiqilgan. Shuningdek, DVR va IVR texnologiyalarining taqqoslama tahlili, qulayligi, inson salomatligiga ta’siri, afzalliklari va kamchiliklari muhokama qilinadi. Turli kasalliklarga ega shaxslar tomonidan VR texnologiyalaridan foydalanish bo‘yicha tavsiyalar ham beriladi. Mazkur yo‘nalishdagi tadqiqotlar tahlil qilinadi.

Kalit so‘zlar: virtual reallik, DVR, IVR, simulyator, virtual ishtirok, ta’limda VR, vestibulyar, proprioseptiv va vizual ma’lumotlar.

Introduction. Today, virtual reality is gradually becoming a part of everyday life at various levels: from household applications (entertainment games), educational

applications in secondary and higher education, to space programs and the management of hazardous industries. The very term “virtual reality” refers to a certain artificial world created with the help of technical means and existing only in digital form. A virtual world can be a replica of the existing world or it can be transmitted to humans through sensory perception-primarily vision, hearing, touch, and so on. Virtual environments may either reproduce real places or be entirely imaginary and unreal (for example, a user can be placed on the surface of another planet or inside a living cell).

Students can manipulate and interact with virtual objects, move within the virtual space, communicate with other students both verbally and non-verbally, create, and play. In such environments, learners demonstrate a high level of subjectivity (subjectivity refers to the ability of an individual to act as a source of action) and autonomy. Virtual reality technology encompasses a range of devices that may differ significantly from one another [5].

Literature Analysis. E.A.-L. Li and K. V. Wong found that children learning biology in VR demonstrated significantly better knowledge outcomes compared to the control group that studied the subject in traditional classroom settings [1]. However, another study comparing instructional delivery methods revealed that, although the IVR group showed higher interest, motivation, and engagement, they performed significantly worse than the PowerPoint group in subsequent tests [1]. The authors attributed this to the violation of the segmentation principle in IVR: unlike segmented instruction, IVR sessions were continuous. Another important principle-coherence, which involves eliminating extraneous objects and functions-was also disrupted, as learners were surrounded by many moving objects irrelevant to the subject matter, which hindered learning in VR.

In the literature, the following types are usually distinguished: Desktop Virtual Reality (DVR) – an environment in which the virtual world is displayed on a computer screen and the student interacts with it using a mouse, touchscreen, hand controllers, and similar devices; and Immersive Virtual Reality (IVR) – an environment delivered through audio-visual devices, precisely tracked head

movements, and controlled via controllers. In this research, the focus is on immersive virtual environments, which are accessed through portable head-mounted displays. In recent years, studies on the application of virtual reality (VR) technologies in educational processes have been conducted on a wide scale, with active discussions regarding their impact on the quality of education, their role in deepening student knowledge, and the opportunities they provide for interactive teaching. At the international level, for instance in the United States and European countries, VR technologies have been widely implemented in the learning process, and research has been carried out from technical, pedagogical, and psychological perspectives. Findings have shown that VR technologies are particularly effective in technical and engineering disciplines, as well as in the study of health sciences, physics, and biology.

Research Methodology. In Central Asia and the CIS countries, interest in this topic is steadily increasing. In Uzbekistan and neighboring states, initial steps are being taken to integrate VR technologies into the educational system; however, the number of studies and practical implementations remains limited. Scholars such as Rustam Qosimov and Abdulaziz Xasanov have conducted research on the integration of VR and AR technologies into technical and engineering education, focusing on identifying the didactic and methodological aspects of these technologies. At the same time, research has also highlighted potential risks associated with the use of VR technologies, such as technology addiction, negative impacts on eye health and mental well-being, as well as the challenges posed by high technological costs. International academic studies have analyzed the physiological and psychological adverse effects of excessive VR use and developed recommendations for the safe and moderate utilization of VR devices. Overall, while numerous studies have explored the integration of VR technologies into education, gaps remain between theory and practice. Therefore, deeper investigation and extensive practical experimentation are required to ensure the safe and pedagogically effective implementation of VR technologies into the learning process. The purpose of studying the prospects and risks of applying

virtual reality (VR) technologies in the educational process is to identify the positive impact of VR on education, to evaluate the opportunities it provides for enhancing students' knowledge and skills, and to analyze the potential risks associated with its use. This research is aimed at exploring how VR technologies can be integrated into the learning process, assessing their influence on the quality of education, and identifying methods to increase pedagogical effectiveness. Furthermore, it focuses on developing approaches for the safe and regulated implementation of VR technologies in education, taking into account health considerations, psychological well-being, and technical infrastructure requirements.

General effects of virtual reality. A person's response to various virtual environments and their interaction with them largely depends on a number of technological features of the environment as well as on the psychological characteristics of the individual. The most crucial factors among these are the sense of immersion and presence. Immersion refers to the use of virtual reality systems to substitute or augment human. The degree of immersion is determined by the technological properties of the VR (virtual reality) environment, such as display size, frame rate, field of view, stereoscopy, stereo sound, tracking accuracy, speed, and other parameters. For example, more photorealistic graphics in VR have been shown to positively affect the level of immersion. The extent of sensory simulation is also significant: the stronger the effect of immersion, the more sensory systems are simultaneously stimulated, the more adequate the diversity of stimuli, and the higher their intensity.

Presence is defined as the subjective experience of "being in a place," even when the subject is physically located elsewhere. There is a strong correlation between immersion and the sense of presence. Moreover, studies have shown that more accurate and faster motion tracking, the use of stereoscopic visual effects, and wider display fields of view are significantly more effective in enhancing immersion than improving many other features of immersive systems. The ability to freely navigate in a virtual environment and to interact with virtual objects-

especially when their physical properties are realistically simulated-has a substantial impact on increasing the sense of presence. A stronger sense of presence is also achieved when the user employs a virtual avatar that realistically replicates human movements through motion capture technologies.

The general effects of virtual reality can influence human psychology, physiology, cognitive activity, and social interactions. The most common general effects include the following: Immersion and sense of presence: VR deeply engages the user in the virtual world while reducing their connection with the real world. This, in turn, enhances the user's feeling of complete involvement in the virtual environment, enabling experiences that are perceived as almost equivalent to real-life situations. Skill reinforcement and increased effectiveness of practical training: VR can be used to safely and interactively teach complex skills. For instance, simulations in medicine, engineering, or aviation allow users to practice hands-on tasks in conditions that closely resemble real-world scenarios.

The Impact of Virtual Reality on Brain Activity, Behavior, and Learning. The evaluation of virtual reality applications in education has often focused not on pedagogical theory or learning outcomes, but rather on the usability of VR applications regularly employed in real-world contexts, with immersive VR technology primarily being part of experimental studies. Research on the use of VR in teaching children has also been conducted only rarely among students of medical and technical specializations. Furthermore, the development of VR applications often does not take into account learning theories based on educational outcomes [4].

Many studies have shown that the use of virtual reality in education has a positive effect on academic performance, and that game-based learning environments are more effective than virtual worlds or simulations. A recent meta-analysis aimed at analyzing the effectiveness of virtual reality in higher education and professional training found that immersive virtual reality has a more positive impact compared to 2D displays. Although VR features sometimes produce

contradictory results in the learning process, its use is steadily increasing. Many studies on the use of VR in education have demonstrated positive effects, which is also confirmed by a large-scale meta-analysis [3]. In this study, all works were classified as follows: traditional methods of presenting educational material (lectures, textbooks, tests, models, or laboratory exercises); multimedia presentation of material (videos, graphics, or computer-based learning tools); and combinations of methods of presenting material that do not provide additional impact (control group), such as desktop-based virtual reality combined with traditional or multimedia methods.

Analysis and Results. The results of the meta-analysis show that the integration of VR into school curricula and higher education in the form of virtual worlds, games, and simulations improves students' academic performance. Moreover, research specifically examining the use of computer simulations in the learning process revealed that students' knowledge levels were higher when using VR simulations compared to traditional skill-based training. This is because in VR it is easier for students to retain factual information rather than develop skills, as skill development requires regular repetition over a long-term process. Recently, the impact of different types of instructional delivery (2D video or immersive VR using Samsung Gear VR headsets) on the effectiveness of initial training was studied [2]. The key empirical finding of this study was that pre-training in IVR significantly improved knowledge acquisition, while no such effect was observed for 2D videos. In addition, the results indicated that pre-training significantly enhanced learners' self-efficacy in IVR learning, but not when learning through 2D videos.

Conclusion. Given the fact that virtual reality devices (VR headsets) have only very recently entered the consumer market, it is not surprising that very few studies have been conducted on their effects on children and adolescents. Their use for educational purposes in real school classrooms remains extremely limited. At the same time, serious ethical concerns arise with regard to the long-term use of

VR devices by children and adolescents, including but not limited to issues related to the nature of VR content itself.

However, the integration of VR technologies into the educational process also presents certain risks and limitations. These include technology addiction, negative health effects (such as eye strain and headaches), psychological discomfort, and the high cost of technical infrastructure. Prolonged use of VR may negatively affect users' health and distance learners from the real world. Therefore, in order to use VR technologies effectively in education, it is necessary to implement safety measures, regulate usage time, and develop methods that correspond to the educational content. Through this approach, the positive impact of VR technologies on the learning process can be maximized while minimizing potential risks.

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