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THE IMPORTANCE OF VIRTUAL REALITY TECHNOLOGIES IN DEVELOPING PROFESSIONAL COMPETENCE

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Buxdu 2- bosqich doktaranti.

Annotation. Modern higher education, particularly medical education, faces numerous challenges that require revisiting theoretical content, redesigning laboratory and hospital practices, strengthening community engagement, and adapting university life to the demands of the digital environment. This article discusses contemporary pedagogical approaches aimed at developing the professional competencies of medical university students. It evaluates the use of simulation technologies, simulation-based teaching, as well as virtual and augmented reality (VR/AR) tools within the educational process. The study identifies the key advantages of utilizing modern simulators and virtual platforms in the training of medical professionals. It also examines the main stages of competency formation and the structure of simulation-based learning environments that ensure effective instruction. Furthermore, attention is given to the practical effectiveness of VR/AR technologies and the limitations faced by educational institutions in their implementation (Strelnikova, 2025).
Keywords: VR/AR technologies, digital transformation, digitalization in medicine, professional competence, modern simulators.

Introduction. In the conditions of modern digital transformation, organizing the educational process on the basis of innovative technologies is fundamentally reshaping the quality indicators of professional training. In particular, virtual reality (VR) technologies have, in recent years, become recognized as one of the most promising directions within the education system. VR technologies make it possible to model real-life processes, recreate complex practical situations in a safe environment, and enrich students' learning through interactive engagement. This not only strengthens theoretical knowledge but also plays a crucial role in developing professional competencies through hands-on experience.

Professional competencies today are interpreted as an integrative set of knowledge, skills, abilities, and personal qualities required for successful performance in the labor market. Solving complex professional tasks, making independent decisions, and finding rapid and effective solutions in problematic situations may be limited by traditional teaching methods. From this perspective, the integration of virtual reality technologies into the educational process enhances the quality of practical training, increases student engagement, and enables the assimilation of learning materials through personal experience.

Higher education institutions have several key objectives associated with the implementation of such VR-based educational experiences, including:

1. **To shape and develop participants' interests and aspirations**—that is, to support them in making informed decisions about the professional fields and population groups they would prefer to work with after graduation.
2. **To expose students to practical problems that require novel approaches**, thereby helping participants develop their own epistemology of practice (Schön, 2001).
3. **To foster participants' reflective abilities** (Knowles et al., 2001) and expand their metacognitive skills (e.g., self-monitoring), ultimately enabling them to gradually evolve into self-directed learners.

This definition encompasses six key characteristics of virtual exchange (VE):

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1. technology-based interaction**;**
2. engagement and communication with individuals from other cultures or countries**;**
3. integration into the curriculum and facilitation by educators or experts**;**
4. a strong emphasis on the development of intrapersonal skills and intercultural competence**;**
5. a student-centered and collaboration-oriented educational approach (O'Dowd, 2023).
Virtual exchange (VE) enables students to continue their studies at their home institution while engaging in interaction and collaboration with students from partner higher education institutions (3).

Figure 1. Simulation-based training conducted using VR

Figure 2. Preparation of medical students for the surgical profession.

Medical students increasingly have the opportunity to engage in specialized training programs based on virtual reality (VR) technologies. These VR simulation systems model the dynamics

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of real surgical procedures with high precision, allowing learners to practice in a safe, controlled, and interactive environment. Using head-mounted displays (HMDs), students enter a fully immersive virtual setting in which they can perform all stages of complex surgical operations in a practical manner.

VR-based training offers several advantages over traditional practical instruction. First, the simulation of real clinical scenarios enables students to repeatedly practice high-risk situations commonly encountered during surgery, which improves the speed and accuracy of clinical decision-making (Figure 1). Moreover, because errors made during VR training pose no real danger, learners experience reduced psychological pressure, thereby enhancing the development of surgical skills and increasing the effectiveness of independent learning.

Scientific studies demonstrate that VR-based simulation sessions significantly contribute to the development of motor skills, activation of cognitive processes, strengthening of spatial perception, and improvement of the precise movements required in surgery. Consequently, students trained with VR technologies enter clinical practice with a higher level of preparedness, greater confidence, and a more comprehensive understanding of surgical procedures (Figure 2).

For these reasons, the integration of VR technologies into surgical education not only increases the interactivity of the learning process but also substantially improves the overall quality of medical training. VR tools represent a highly promising innovative approach in the preparation of future surgeons and serve as an effective pedagogical complement to traditional methods of practical instruction.

Research Findings: Stress Resilience of Students Trained with VR Technologies Compared to Those in Traditional Instruction. Within the scope of the study, a total of 10 medical students were involved in real clinical practice designed for surgical training. Five of these students completed repeated immersive surgical simulations using VR technologies, while the remaining five students completed the course through traditional classroom-based instruction.

During the practical session, all participants were administered a Stress Susceptibility Test (SST). In this assessment, students were evaluated on their ability to manage risk, pressure, time constraints, and complex decision-making within a realistic surgical environment.

The results demonstrated that students trained with VR technologies performed **46% more effectively** in carrying out surgical tasks under stress compared to their peers who received traditional instruction. This difference is attributed to the high level of immersion, opportunities for repeated practice, and the psychologically safe simulation environment that enhances mental preparedness.

Table 1. Comparison of Stress Test Results Between the VR Group and the Traditionally Trained Group (0–100 points)

Table 1. Comparison of Stress Test Results Between the VR Group and the Traditional Group

№	Student Group	Stress Test Score	Performance Quality (%)	Number of Errors	Comment
1	VR	92	96	1	high concentration and clinical stability
2	VR	88	94	2	strong situational assessment ability

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3	VR	90	95	1	precise motor movements
4	VR	85	91	3	stable under stress
5	VR	89	93	2	completed surgical stages fully
6	Traditional	60	64	6	strong impact of stress
7	Traditional	58	62	7	slow decision-making
8	Traditional	52	59	8	insufficient practical experience
9	Traditional	55	61	7	imprecise hand movements
10	Traditional	63	66	5	more errors under pressure

Scientific Analysis of the Results

Based on the obtained data, the following scientific conclusions can be drawn:

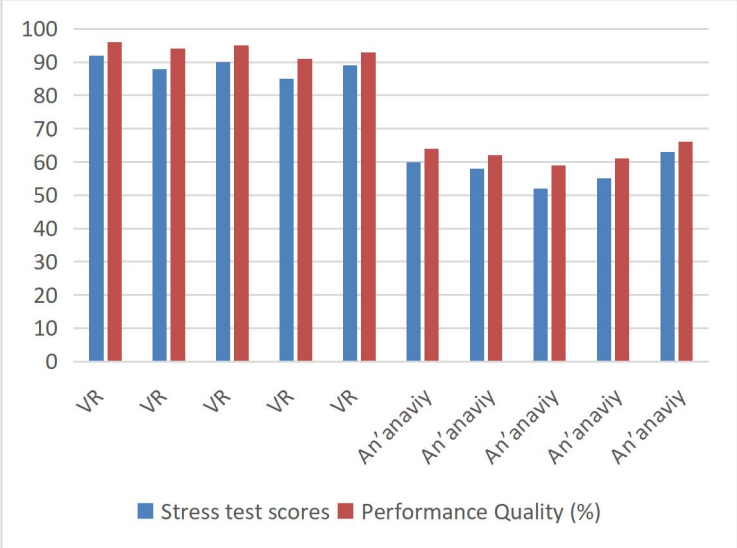

Figure 1. Students' Stress Test Results

1. VR technologies significantly increase stress resilience

The VR group achieved an average score of **88.8**, whereas the traditional group scored an average of **57.6**. This represents a **46% higher performance** for students trained with VR technologies.

2. VR simulations strengthen students' psychological stability

Repeated training in an immersive environment allows learners to "experience" the clinical setting in advance. As a result, fear, stress, and uncertainty are considerably reduced.

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3. Motor and cognitive skills are more developed in the VR group

Students trained through VR demonstrated:
- improved precision of hand movements
- faster situational decision-making
- fewer operational errors
- stronger retention of surgical procedural steps

4. Traditional training is insufficient for preparing students for surgical stress

In traditional instruction, the real pressures of surgery are absent. Therefore, in actual clinical settings students tend to:
- make more errors
- struggle to adapt to the situation
- have difficulty managing stress

Conclusion. The findings confirm that VR technologies possess high effectiveness in medical education, particularly in enhancing practical surgical training. The immersive and realistic environment allows students to repeatedly practice complex surgical scenarios safely, manage stress more effectively, improve motor coordination, and strengthen decision-making skills. Moreover, VR-based training develops psychological readiness more efficiently than traditional teaching methods.

Overall, the results demonstrate that integrating VR technologies into medical education is a promising innovative approach that enhances both the safety and quality of surgical training.

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