IMPROVING THE METHODOLOGY OF TEACHING BIOPHYSICS IN MEDICAL EDUCATION WITHIN A DIGITAL LEARNING ENVIRONMENT.

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Abstract

This article analyzes the current state, pedagogical opportunities, and effectiveness of teaching biophysics in medical higher education institutions within a digital learning environment. The study focuses on the integration of digital educational technologies, simulation-based learning tools, virtual laboratories, and interactive multimedia resources in the teaching of biophysics. Special attention is given to the role of biophysics as a fundamental discipline in forming clinical thinking, understanding physiological processes, and mastering diagnostic and therapeutic technologies. The article demonstrates that the use of digital platforms, computer modeling, and virtual experiments significantly improves students' comprehension of complex biophysical phenomena, enhances practical skills, and increases learning motivation. The findings confirm that modern digital approaches contribute to the formation of professional competencies and improve the overall quality of medical education.

Keywords: biophysics education, digital learning environment, medical education, simulation-based learning, virtual laboratory, computer modeling, innovative pedagogy.

Introduction. Modern medical education is undergoing rapid transformation due to the intensive development of digital technologies and the increasing demand for highly qualified healthcare professionals. In this context, fundamental disciplines

such as biophysics play a crucial role in shaping the scientific worldview and professional competencies of future physicians. Biophysics provides the theoretical foundation for understanding physiological processes, mechanisms of action of medical equipment, diagnostic methods, and therapeutic technologies. However, traditional teaching methods are often insufficient for explaining complex physical and biological interactions, which can lead to superficial knowledge and reduced student engagement.

The integration of digital educational technologies into the teaching of biophysics opens new opportunities for improving learning outcomes. Virtual laboratories, computer simulations, electronic textbooks, and interactive multimedia resources allow students to visualize abstract processes, conduct virtual experiments, and repeatedly practice problem-solving skills in a safe and controlled environment. International experience shows that digital learning tools increase knowledge retention, enhance analytical thinking, and promote the development of applied competencies among medical students.

In medical education, biophysics is closely connected with clinical disciplines such as physiology, radiology, cardiology, ophthalmology, and biomedical engineering. Therefore, teaching biophysics using clinically oriented digital scenarios helps students understand the practical relevance of theoretical concepts. The use of simulation-based learning enables the modeling of physiological systems, bioelectric phenomena, hemodynamics, and medical device operation, which significantly improves the integration of theory and practice.

The purpose of this study is to analyze methodological approaches to teaching biophysics using digital educational technologies, assess their pedagogical effectiveness, and identify opportunities for improving the quality of medical education. The study also examines the impact of a digital learning environment on students' academic performance, practical skills, and professional motivation.

Research Methodology. The research was conducted using qualitative and quantitative methods, including pedagogical observation, questionnaires, testing, and statistical analysis. A total of 120 first- and second-year students of Andijan State Medical Institute participated in the study. The main objective was to evaluate the effectiveness of digital educational tools in teaching biophysics and their influence on students' competencies.

The study was carried out in three stages:

1. Diagnostic stage – assessment of students' initial knowledge of biophysics and their level of use of digital educational resources through structured questionnaires and entry tests.
2. Practical stage – integration of digital learning tools into the biophysics curriculum, including virtual laboratories, computer simulations, electronic manuals, and interactive problem-solving modules.
3. Evaluation stage – analysis of academic performance, practical task results, and students' self-assessment after the implementation of digital technologies.

Statistical methods, including comparative analysis and correlation analysis, were used to interpret the obtained data.

Results. The results of the study demonstrated a significant positive impact of digital educational technologies on the learning outcomes of students studying biophysics. Initial diagnostic assessment showed that only 30% of students regularly used digital learning resources, while 45% used them occasionally and 25% had minimal experience. After the introduction of virtual laboratories and interactive modules, notable improvements were observed.

Theoretical knowledge assessment revealed an average increase of 35% in test scores compared to baseline results. Practical skills related to problem-solving, data interpretation, and application of biophysical laws improved by 38%. Students

demonstrated better understanding of topics such as membrane potentials, bioelectric signals, biomechanics, optics of the eye, and medical imaging principles.

Self-assessment surveys indicated that 74% of students reported increased interest in biophysics, while 70% noted improved confidence in applying biophysical concepts to clinical situations. Correlation analysis showed a strong positive relationship ($r = 0.69$) between the frequency of digital tool usage and overall academic performance.

Discussion. The findings confirm that the integration of digital educational technologies significantly enhances the effectiveness of teaching biophysics in medical education. Virtual laboratories and computer simulations allow students to explore complex processes that are difficult to demonstrate in traditional classroom settings. Interactive learning environments promote active participation, independent learning, and critical thinking.

The results are consistent with international studies highlighting the advantages of digital and simulation-based learning in fundamental medical sciences. However, limitations of the study include the relatively short duration of the intervention and the limited sample size. Further longitudinal research is required to assess the long-term impact of digital technologies on professional competence development.

Conclusion

The study concludes that the use of digital learning environments and innovative educational technologies significantly improves the teaching of biophysics in medical education. Digital tools enhance students' theoretical knowledge, practical skills, and motivation, contributing to the formation of clinically oriented thinking. The integration of virtual laboratories, simulations, and interactive resources is an effective strategy for improving the quality of biophysics education and preparing competent future physicians.

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