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THE EFFECTIVENESS OF TEACHING BIOPHYSICS THROUGH MODERN PEDAGOGICAL APPROACHES

Abstract. *This article analyzes the role of biophysics in medical education, its practical significance, its role in the formation of competencies necessary for future doctors, and the main directions of biophysical research methods in modern medicine. Despite the complexity and interdependence of various processes occurring in the human body, it is often possible to distinguish among them those that are close to physical processes. For example, such complex physiological processes as blood circulation are actually physical processes, since this process is associated with the flow of fluid - hydrodynamics, the propagation of elastic vibrations along the vessel - vibrations and waves, the mechanical work of the heart - mechanics, the generation of biopotentials - electricity, etc.*

Key words*: Biophysics, medical imaging, physics of biological processes, diagnostic technologies, electrophysiology, medical visualization, MRI, EKG, UTT, radiobiology, medical equipment, signal processing, biomechanics, medical physics, educational methods, virtual laboratory, medical technologies*

Many principles and concepts of diagnostics and research are based on physical foundations. Most modern medical instruments, in terms of their structure, are physical devices. Mechanical quantities—such as blood pressure—serve as indicators for assessing a range of diseases. The ability to hear sounds originating within the body allows clinicians to obtain information about the health or pathology of organs. The operation of the medical thermometer, a widely used diagnostic tool, is based on the thermal expansion of mercury.

In recent years, with the development of electronic devices, diagnostic methods based on recording bio-potentials generated by living organisms have become widespread. A well-known example is electrocardiography, which records bio-potentials reflecting cardiac activity. The significance of the microscope in medical and biological research is universally recognized. Modern medical instruments based on fiber optics enable visualization of internal body cavities. Spectral analysis methods are applied in forensic medicine, hygiene, pharmacology, and biology. Advances in atomic and nuclear physics have led to widely used diagnostic methods such as X-ray imaging and techniques utilizing labeled atoms.

All processes occurring in the body—such as electrical signaling, substance exchange across membranes, blood flow, and respiratory mechanics—are governed by physical laws. Biophysics provides a medical perspective by explaining the mathematical and physical models of these processes.

It teaches the scientific foundations of diagnostic methods. Modern medicine relies on technologies based on the following physical principles:

- Electroencephalography (EEG)
- Electrocardiography (ECG)
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasonography (US)

Biophysics courses teach students the mechanisms of operation of these technologies, the properties of waves, and the principles of signal processing.

Medical Imaging

Biophysics explains the physical principles underlying processes in medical imaging, such as nuclear magnetic resonance in MRI, electromagnetic radiation in X-rays, and mechanical waves in ultrasonography (US).

Radiobiology

Knowledge of the effects of ionizing radiation on biological tissues is crucial in oncology, radiology, and the implementation of protective measures.

Requirements for Teaching Biophysics Using Interactive Methods

The study of the requirements for teaching biophysics through interactive methods was conducted using the following approaches. The research involved a comprehensive review of the literature, analysis of existing scientific publications, and evaluation of pedagogical practices, providing insights into the role and significance of interactive methods in biophysics education.

The effectiveness of these teaching methods was assessed by comparing traditional approaches with interactive techniques and by examining the development of interactive methods as a pedagogical strategy through scientific articles and research studies. Additionally, the study included a comparative analysis of 147 groups taught using interactive versus traditional methods, measuring students' learning outcomes, participation, and overall engagement in the educational process.

Scientific Outcomes of Using Interactive Methods in Biophysics Education

The scientific results of applying interactive methods in teaching biophysics can be summarized in several key aspects:

Validation of Effectiveness: Research has demonstrated the effective use of interactive methods in biophysics education and their importance in reinforcing students' knowledge. Interactive techniques—such as group work, problem-based learning, simulations, and multimedia tools—significantly increase student engagement and enhance the learning process. The findings provide clear evidence that interactive methods promote the development of students' knowledge, understanding, and analytical thinking skills.

Enhancing Learning Efficiency: The study investigated the impact of integrating interactive methods on learning outcomes. Results indicated that students acquire not only theoretical knowledge but also practical skills through

these methods. They encourage active participation, independent thinking, and the ability to solve complex medical problems.

Improving Teaching Methods: Effective strategies for combining traditional and interactive approaches in biophysics education were developed. The research showed that integrating interactive methods with conventional teaching enhances knowledge assimilation and improves overall instructional effectiveness. Recommendations were provided for educators on incorporating interactive methods into curricula.

Advancing Educational Methodology: The study concluded that implementing interactive methods introduces a new stage in teaching methodology. Interactive methods complement traditional approaches and play a crucial role in developing students' practical competencies. The findings indicate that using interactive methods is not only effective in biophysics education but can also be beneficial across other medical disciplines. These approaches help students actively assimilate knowledge and contribute to improving the overall quality of higher medical education.

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