TEACHING BIOPHYSICS USING PHET, KAHOOT, AND ELECTRONIC LEARNING PLATFORMS.

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Abstract

The digital transformation of medical education has led to the widespread adoption of interactive and technology-enhanced teaching tools. Biophysics, as a fundamental preclinical discipline, requires effective visualization and active learning strategies to ensure deep understanding of complex physical and biological processes. This article explores the pedagogical potential of using PhET interactive simulations, the Kahoot game-based assessment system, and electronic learning platforms in teaching biophysics. The study analyzes their impact on student engagement, motivation, conceptual understanding, and learning outcomes in medical education.

Keywords: biophysics education, PhET simulations, Kahoot, electronic learning platforms, medical education, digital learning, interactive teaching methods, learning outcomes

Introduction. Modern medical education increasingly emphasizes student-centered learning, the development of critical and analytical thinking, and the formation of professional competencies required for effective clinical practice. In response to rapid scientific progress, digital transformation of healthcare, and the growing complexity of medical technologies, higher medical education institutions are actively revising traditional teaching models. As a result, the integration of digital educational technologies has become an essential component of

contemporary teaching strategies, particularly in preclinical disciplines, where fundamental scientific knowledge forms the basis for further clinical training.

Biophysics occupies a central position in medical education by providing the physical foundations of physiological processes, diagnostic methods, and therapeutic technologies. It enables students to understand the mechanisms underlying bioelectric phenomena, membrane transport, diffusion processes, biomechanics, hemodynamics, and modern medical imaging techniques. Mastery of biophysics is essential for interpreting diagnostic data, understanding the operation of medical equipment, and applying physical principles in clinical decision-making.

Despite its importance, biophysics is often perceived by medical students as an abstract and mathematically challenging discipline. The complexity of theoretical concepts, insufficient visualization of dynamic processes, and limited opportunities for hands-on experimentation can lead to reduced learning motivation, superficial understanding, and lower academic performance. These difficulties may also negatively affect long-term knowledge retention and the ability to transfer theoretical knowledge to clinical contexts.

In this regard, the application of interactive digital tools such as PhET interactive simulations, the Kahoot game-based learning platform, and electronic learning management systems is considered an effective approach to improving the quality of biophysics education. PhET simulations allow students to visualize and model complex biophysical processes by manipulating parameters and observing outcomes in real time. Kahoot enhances student engagement and motivation through interactive quizzes and immediate feedback, transforming assessment into an active learning experience. Electronic learning platforms support blended and self-directed learning by providing access to educational resources, organizing independent study, and facilitating communication between students and instructors.

The combined use of these digital tools promotes active participation in the learning process, encourages independent and collaborative learning, and supports

the development of critical thinking and problem-solving skills. Consequently, the integration of interactive digital technologies contributes to improved conceptual understanding, higher academic achievement, and more effective preparation of future physicians for clinical practice.

Materials and Methods

The study was conducted among undergraduate medical students enrolled in a biophysics course. A blended learning approach combining traditional lectures with digital tools was implemented. The following educational technologies were used:

- **PhET Interactive Simulations:** Used to visualize and model biophysical processes such as diffusion, membrane potential formation, electric circuits in biological systems, and wave phenomena.
- **Kahoot Platform:** Applied as a game-based formative assessment tool to reinforce theoretical knowledge, increase student motivation, and provide immediate feedback.
- **Electronic Learning Platforms:** Learning management systems (LMS) were used to distribute educational materials, organize independent learning, conduct online assessments, and support communication between students and instructors.

The effectiveness of these tools was evaluated through analysis of academic performance, student participation rates, and feedback questionnaires.

Results

The integration of PhET simulations, Kahoot, and electronic learning platforms had a positive impact on the teaching and learning of biophysics. Students demonstrated improved understanding of abstract concepts and increased engagement during classes.

PhET simulations enhanced conceptual clarity by allowing students to manipulate variables and observe real-time changes in simulated experiments. Kahoot significantly increased student participation and motivation, creating a

competitive and interactive learning environment. Electronic learning platforms facilitated continuous learning, improved accessibility to educational resources, and supported self-directed study.

Quantitative analysis revealed higher average test scores and better knowledge retention compared to traditional teaching methods. Student feedback indicated increased interest in biophysics and greater confidence in applying theoretical knowledge to medical contexts.

Discussion

The results confirm that the use of PhET, Kahoot, and electronic learning platforms is an effective strategy for teaching biophysics. These tools promote active learning, immediate feedback, and continuous assessment, which are essential elements of modern medical education.

PhET simulations are particularly valuable for visualizing complex biophysical processes that are difficult to demonstrate in traditional laboratories. Kahoot enhances formative assessment by transforming evaluation into an engaging learning activity. Electronic learning platforms provide organizational structure and support blended and distance learning models.

However, successful implementation requires appropriate technical infrastructure, methodological planning, and digital competence of instructors. The integration of these tools should be aligned with learning objectives and curriculum requirements.

Conclusion

The use of PhET simulations, Kahoot, and electronic learning platforms significantly improves the effectiveness of teaching biophysics in medical education. These technologies enhance student motivation, conceptual understanding, and learning outcomes, while supporting the development of independent learning skills and professional competencies.

The findings suggest that digital interactive tools should be systematically incorporated into biophysics curricula in medical universities. Further research is recommended to assess long-term educational outcomes and to optimize instructional design models.

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