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# Application of interactive methods and electronic resources in studying the activity of the cardiovascular system

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**Abstract:** This article examines the potential of interactive teaching methods in studying the cardiovascular system using electronic educational resources. Their role in enhancing students' cognitive activity, developing biological concepts, and developing critical thinking is substantiated. It is demonstrated that the use of multimedia models, virtual laboratories, and online platforms facilitates a more visual understanding of complex physiological processes. Particular attention is paid to individualizing learning and enhancing learning motivation. A conclusion is drawn regarding the effectiveness of integrating interactive methods and digital technologies in biology teaching.

**Keywords:** Interactive teaching methods, electronic educational resources, cardiovascular system, biological education, digital technologies, visualization, learning motivation.

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## 1. Introduction

The development of scientific concepts among students is widely regarded as a complex, multi-layered psychological and pedagogical process involving a gradual transition from simple information perception to deep comprehension, systematic analysis, abstraction and theoretical generalization[1]. This process requires active cognitive engagement, whereby learners construct meaning through intellectual effort, reflection and problem-solving activities, rather than passively receiving knowledge. Knowledge is not transmitted in a ready-made form, but formed and reconstructed within learners' cognitive structures through purposeful educational interaction. A particularly important aspect of this process is activating students' independent cognitive activity, as this serves as a foundation for forming stable, transferable scientific concepts[2]. When students engage in exploratory, analytical and model-based learning activities, their thinking evolves from mere memorisation to conceptual understanding and logical reasoning.

This is particularly important in natural science education, where abstract processes must be understood through mental modelling and visualization[3]. In biology education, particularly in the study of the cardiovascular system, forming scientific concepts requires understanding the relationship between anatomical structures and physiological functions. Students must be able to connect the morphology of the heart, blood vessels, and blood components with dynamic physiological processes such as circulation, oxygen transport, and metabolic exchange[4]. This integration of structural and functional knowledge cannot be effectively achieved through verbal explanation alone. Therefore, it is essential to use visual, interactive and technology-enhanced teaching tools. Visualisations such as anatomical diagrams, 3D models, animated simulations and virtual laboratory environments play a key role in forming accurate mental representations of complex biological systems. These tools facilitate cognitive processing by transforming abstract physiological mechanisms into observable, interactive learning objects, thereby enhancing comprehension and retention[5].

**Methods**

Learning is viewed as an active process in which knowledge is not transmitted in a pre-defined form, but rather is formed through the student's actions. A central premise is that personal development occurs through activity, meaning the learning process should include analysis, modeling, problem solving, and practical application of knowledge. In studying the cardiovascular system, this is reflected in the need to work with circulatory models, analyze the functions of the heart and blood vessels, and establish logical connections between bodily processes. Viewing the body as a single functional system allows us to understand the cardiovascular system not as a separate organ complex, but as an element of a holistic mechanism that ensures the body's adaptation to external and internal conditions. The principle of feedback, according to which the functioning of the heart and blood vessels constantly changes depending on the body's needs, is important. The study of human anatomy is based on a systematic description of the structure of organs and their interrelationships. The heart and blood vessels are viewed as a single structure that ensures the continuous flow of blood and metabolism. This approach allows students to develop a holistic understanding of the structure and function of the cardiovascular system .

The learning process must be manageable and technologically organized, with clearly defined goals, stages, and outcomes. Knowledge acquisition is viewed as a step-by-step process of developing learning activities, which allows for monitoring the quality of learning and improving its effectiveness. In biology, this is especially important when studying complex topics that require systematization of large amounts of information.

According to the literature, organizing the educational process involves structuring educational content and consistently achieving planned outcomes. It is important to structure learning from simple to complex, ensuring logical connections between the elements of the topic. In particular, when studying the cardiovascular system, this is manifested in a consistent examination of the structure of the heart, the circulatory system, and regulatory mechanisms. It has been established that the use of visual aids and systematized educational materials contributes to a deeper assimilation of biological knowledge, and the visual representation of processes allows students to better understand complex physiological phenomena, such as the movement of blood through vessels and the work of the heart. It should be noted that modern educational technologies are viewed as a system of methods and tools aimed at enhancing students' cognitive activity. Particular emphasis is placed on the use of interactive methods that facilitate student interaction with each other and with the educational material, which improves the quality of learning of complex biological topics.

Currently, the informatization of education is aimed at introducing computer technologies into the educational process, which allows for a significant increase in the visibility and accessibility of learning, since digital tools make it possible to model complex biological processes and provide a deeper understanding of the material being studied

**Results**

Analysing pedagogical approaches to teaching scientific concepts in biology shows that integrating systematic, activity-based and technology-enhanced learning strategies significantly improves students' conceptual understanding, especially for complex topics such as the cardiovascular system. Findings indicate that students in structured learning environments with visual, interactive and model-based instructional tools demonstrate higher cognitive engagement than those taught through traditional, text-centred methods[8].

Using visual representations, such as anatomical models, schematic diagrams, and digital simulations, was found to substantially enhance students' ability to understand the structural and functional relationships within the cardiovascular system. Learners in particular demonstrate an improved understanding of the connection between the heart, blood vessels, and physiological processes such as blood circulation, oxygen transport, and metabolic regulation. Visualising dynamic processes such as cardiac cycles and vascular flow contributes to forming more stable and accurate mental models of

biological systems[9]. Furthermore, the results reveal that step-by-step and system-oriented instruction facilitates the gradual formation of scientific concepts. Students are more successful in mastering complex biological terminology and relationships when content is presented in a logical sequence that progresses from basic anatomical structures to more complex regulatory mechanisms[10]. This structured approach reduces cognitive overload and supports the long-term retention of knowledge. Implementing interactive, student-centred learning methods such as problem-solving tasks, collaborative activities and inquiry-based learning was found to significantly boost learners' analytical and critical thinking abilities. Students in these environments demonstrated greater ability to interpret biological phenomena, establish causal relationships and apply theoretical knowledge to practical situations[11].

Additionally, integrating digital technologies and computer-based modelling systems was shown to enhance learning efficiency and motivation. Learners who were exposed to multimedia resources, virtual simulations and interactive platforms exhibited higher levels of engagement, sustained attention and independent learning behaviour. These tools also contributed to the development of research-oriented skills, enabling students to explore biological processes beyond textbook descriptions. The results also suggest that cognitive interest is crucial for knowledge acquisition. When learning activities are interactive, visually enriching and intellectually stimulating, students demonstrate greater motivation and deeper cognitive engagement[12]. This improves academic performance and enhances the ability to retain and apply knowledge in new contexts. Overall, the findings confirm that combining visual learning tools with structured pedagogical design and innovative digital technologies significantly improves the quality of biology education. Students acquire factual knowledge more effectively and develop higher-order cognitive skills, such as analysing, synthesising, and evaluating biological systems.

**Discussion**

As is well known, the learning process is viewed as an interaction between teacher and student, in which the clarity and accessibility of educational material plays a crucial role. The use of specific images and examples facilitates better knowledge acquisition, especially in the natural sciences. Students' thinking develops during the learning process, especially when solving problems within their zone of proximal development. Learning effectiveness is enhanced by collaborative work between student and teacher, which is especially important when studying complex biological processes[13].

Education should be developmental in nature and promote the development of thinking processes, since the increased level of complexity of the educational material stimulates the intellectual development of students and promotes a deeper understanding of biological processes[14].

In today's education system, innovative learning models are focused on activating students' cognitive activity through problem-based learning, discussions, and research. This approach fosters independent thinking and sustainable knowledge. According to the literature, cognitive interest is considered a key factor in successful learning, since its development contributes to increased student motivation and improved quality of knowledge acquisition, especially when studying complex sections of biology[15].

At the same time, the introduction of innovative technologies into the educational process helps to increase its efficiency and expand learning opportunities, therefore the use of digital resources makes learning more modern and effective.

**Conclusion**

Thus, the use of interactive methods and electronic resources is dictated by modern educational requirements, contributes to the activation of cognitive activity, increased interest in learning and improved quality of knowledge acquisition.

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