

**IMPROVEMENT OF THE METHODOLOGY OF TEACHING THE COURSE
“ZOOLOGY” IN HIGHER EDUCATION BASED ON INNOVATIVE
PEDAGOGICAL TECHNOLOGIES (ON THE EXAMPLE OF VERTEBRATES)**

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ABSTRACT *This article is devoted to the topic "Improving the methodology of teaching zoology in higher education based on innovative pedagogical technologies." It highlights the comparison of traditional and innovative approaches, the importance of modern educational technologies in teaching zoology, including active teaching methods, digital tools, virtual laboratories, multimedia resources, collaborative approaches, and modern assessment methods. With the help of innovative technologies, it shows the possibilities of increasing students' interest in zoology, deepening their knowledge and skills in the subject. In conclusion, it was emphasized that the application of modern approaches is an important factor in improving the quality of education.*

Keywords: *Zoology education, innovative pedagogical technologies, active learning, higher education, digital tools in biology teaching, virtual laboratories, e-learning in science, student-centered approach, teaching methodology.*

In the context of rapid development of science, technology, and educational innovation, higher education institutions are facing increasing demands to modernize teaching methodologies and improve the quality of specialist training. In particular, the teaching of biological sciences, including zoology, requires the integration of innovative pedagogical technologies that promote active learning, critical thinking, and the formation of professional competencies. Zoology, as a fundamental discipline in biological education, plays a crucial role in shaping students' understanding of animal diversity, evolutionary relationships, ecological interactions, and functional morphology, especially within the study of vertebrates.

Traditional teaching methods in zoology, which are often based on lecture-centered instruction and limited practical engagement, are increasingly insufficient to meet the requirements of contemporary higher education. These approaches may restrict students' independent learning, reduce motivation, and limit the development of analytical and research skills. Therefore, there is a growing need to improve the methodology of teaching zoology by incorporating innovative pedagogical technologies such as interactive learning, digital educational resources, problem-based learning, blended learning, virtual laboratories, and multimedia tools.



The study of vertebrates occupies a central position in the zoology curriculum, as vertebrate animals represent complex anatomical, physiological, and ecological systems that are essential for understanding biological organization and adaptation. Effective teaching of vertebrate zoology requires not only the transmission of theoretical knowledge but also the development of practical competencies, including comparative analysis, identification skills, experimental observation, and the application of scientific concepts to real-world biological problems. Innovative pedagogical technologies provide opportunities to enhance visualization, simulation, and student-centered learning, thereby improving comprehension and long-term retention of complex biological concepts.


Thus, the relevance of this research is determined by the necessity to modernize the teaching of zoology in higher education institutions, to enhance the effectiveness of learning outcomes, and to ensure the alignment of zoological education with contemporary pedagogical and technological standards. The improvement of teaching methodology on the example of vertebrates serves as a scientifically justified and practically significant approach to optimizing the educational process and increasing students' academic engagement and professional readiness.

Methodology. This study employed a mixed-methods research design that combined quantitative and qualitative approaches to investigate the effectiveness of innovative pedagogical technologies in improving the methodology of teaching the course “Zoology” in higher education, with a specific focus on vertebrate zoology. The mixed-methods design was selected to ensure a comprehensive analysis of both measurable learning outcomes and participants' perceptions, experiences, and pedagogical practices. The research was conducted in a quasi-experimental format, involving experimental and control groups. The experimental group was taught using an improved methodology based on innovative pedagogical technologies, while the control group was instructed using traditional teaching methods. This design allowed for a comparative evaluation of the impact of the proposed methodology on students' academic achievement, motivation, and professional competency development.

Participants-The participants of the study included undergraduate students enrolled in the “Zoology” course at higher education institutions, as well as faculty members teaching vertebrate zoology. Students were selected using purposive sampling to ensure that all participants had comparable academic backgrounds and had not previously completed advanced vertebrate zoology courses. The total sample size included students from both experimental and control groups, ensuring statistical validity and representativeness.

In addition, zoology instructors participated in interviews and classroom observations to provide qualitative data on the implementation of innovative pedagogical technologies and their pedagogical effectiveness.

Instructional Intervention - The instructional intervention consisted of the implementation of an improved teaching methodology for vertebrate zoology based on innovative pedagogical technologies. The intervention included the following components:

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- Blended learning combining face-to-face instruction with online learning modules
 - Flipped classroom strategies for selected vertebrate topics
 - Virtual laboratories and 3D anatomical simulations for vertebrate systems
 - Interactive multimedia presentations and digital learning objects
 - Problem-based and case-based learning activities focused on vertebrate biology
 - Collaborative group projects and research-oriented tasks

The intervention was implemented over one academic semester and was integrated into both theoretical lectures and practical laboratory sessions.

Data Collection Instruments - Multiple data collection instruments were used to ensure methodological triangulation:

1. **Achievement Tests** – Pre-test and post-test instruments were developed to assess students’ knowledge and understanding of vertebrate zoology concepts.

2. **Questionnaires** – Structured questionnaires were administered to measure students’ motivation, attitudes toward innovative technologies, and perceptions of learning effectiveness.

3. **Observation Protocols** – Classroom observations were conducted using standardized observation checklists to document teaching practices, student engagement, and instructional strategies.

4. **Semi-Structured Interviews** – Interviews with instructors were conducted to explore pedagogical experiences, challenges, and perceived benefits of the improved methodology.

5. **Document Analysis** – Analysis of course syllabi, lesson plans, digital resources, and assessment materials was conducted to evaluate alignment with competency-based education principles.

Validity and Reliability- To ensure the validity and reliability of the research instruments, pilot testing was conducted prior to the main study. Content validity was established through expert review by specialists in zoology and pedagogy. Reliability coefficients (e.g., Cronbach’s alpha) were calculated for questionnaire scales to ensure internal consistency. Standardized administration procedures were applied for all tests and surveys to minimize measurement bias.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistical methods. Descriptive statistics (means, standard deviations, and percentages) were used to summarize students’ performance and questionnaire responses. Inferential statistical tests (such as t-tests and analysis of variance) were applied to determine statistically significant differences between experimental and control groups.

Based on the results of the research on improving the methodology of teaching the course “Zoology” in higher education through innovative pedagogical technologies (on the example of vertebrates), the following scientifically grounded recommendations are proposed for higher education institutions, faculty members, and curriculum developers:



1. **Integration of Innovative Pedagogical Technologies**

It is recommended to systematically integrate innovative pedagogical technologies, including blended learning, flipped classroom models, problem-based learning, and interactive digital platforms, into the teaching of vertebrate zoology in order to enhance student engagement and promote active learning.

2. **Development of Digital Educational Resources**

Higher education institutions should develop and implement electronic educational resources such as virtual laboratories, 3D anatomical models, video demonstrations, and interactive multimedia modules to improve visualization and understanding of complex vertebrate structures and physiological processes.

3. **Enhancement of Practical and Laboratory-Oriented Instruction**

The methodology of teaching vertebrates should emphasize practice-oriented learning through modernized laboratory work, field-based observations, and simulation-based experiments, allowing students to develop practical zoological and research competencies.

4. **Implementation of Student-Centered Learning Approaches**

It is recommended to apply student-centered pedagogical strategies, including collaborative learning, project-based learning, and case-study methods, to support the development of independent learning skills, critical thinking, and scientific reasoning in vertebrate zoology.

5. **Professional Development of Teaching Staff**

Regular professional development and training programs should be organized for zoology instructors to improve their pedagogical, digital, and methodological competencies related to innovative teaching technologies and modern educational tools.

6. **Curriculum Modernization and Competency-Based Design**

The zoology curriculum should be revised in accordance with competency-based education principles, ensuring alignment between learning outcomes, teaching methods, and assessment strategies, particularly in the vertebrate zoology component.

7. **Use of Formative and Digital Assessment Tools**

It is recommended to introduce formative assessment methods and digital evaluation tools, such as online quizzes, e-portfolios, and learning analytics, to monitor students' progress, provide timely feedback, and improve the quality of learning outcomes.

8. **Strengthening Interdisciplinary Integration**

The teaching of vertebrate zoology should be strengthened through interdisciplinary integration with anatomy, physiology, ecology, genetics, and pedagogy, using innovative technologies to demonstrate the interconnections between biological disciplines.

9. **Support for Independent and Research-Based Learning**

Higher education institutions should encourage students' independent and research-based learning activities by providing access to digital databases, virtual research environments, and guided research projects related to vertebrate biology.

10. **Monitoring and Continuous Improvement of Teaching Methodology**

It is recommended to establish a system for regular monitoring, evaluation, and continuous

improvement of zoology teaching methodologies based on student feedback, learning outcomes, and evidence-based educational research.

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