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## METHODOLOGICAL FOUNDATIONS FOR STUDYING ANIMAL DIVERSITY FOR BIOLOGY STUDENTS IN PEDAGOGICAL EDUCATION

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**Abstract.** This article examines the methodological foundations of teaching the study of animal diversity to biology students in pedagogical programs. The relevance of the research is determined by the need to align biological education with modern environmental and digital requirements. The aim of the study is to identify methodological approaches, effective pedagogical technologies and the level of practical training in teaching animal diversity through a comparative analysis of the pedagogical systems of Kazakhstan and Turkey (using Hacettepe University as an example). The research involved surveys and interviews conducted among students and faculty members of Hacettepe University, as well as an analysis of curricula and the content of practical classes. The results showed that Turkish universities, particularly Hacettepe University, widely apply research-based and interactive teaching methods such as project-based learning, laboratory work and field practice. At the same time, the study was not limited to Turkish experience: similar surveys were conducted among biology students in pedagogical universities of Kazakhstan. The results of the Kazakhstani survey indicated that, despite students' high interest in practical lessons, the number of laboratory and field sessions remains insufficient. Although traditional theoretical teaching still prevails in Kazakhstani universities, recent years have seen the gradual introduction of problem-based learning and digital models. Most students emphasized the need for active use of digital tools – such as virtual laboratories and biological modeling platforms when studying ecosystems and animal diversity. These approaches enhance students' learning engagement and develop their practical competencies. In this regard, adapting Turkey's best educational practices to the context of Kazakhstani higher education institutions, the authors developed lesson plans and methodological recommendations for teaching courses related to the study of animal diversity. The findings of the study revealed that the effectiveness of teaching animal diversity depends not only on the content but also on the applied teaching methods.

**Keywords:** Pedagogical education, biological education, teaching methodology, project-based learning, practical competence, biological diversity, animal world, digital technologies

### Introduction

Modern pedagogical education in biology requires a rethinking of methodological approaches to studying animal diversity – one of the fundamental

disciplines that shape the practical and research competencies of future teachers. In the context of global environmental challenges and the rapid development of digital technologies, it has become increasingly important to train educators who are capable not only of transmitting knowledge about animals but also of fostering scientific thinking, empathy toward living organisms, and environmental responsibility among students.

In Kazakhstan, the modernization of biological and pedagogical education corresponds to the strategic priorities defined by national policy frameworks. This alignment is evident in such foundational documents as the State Program for the Development of Education and Science of the Republic of Kazakhstan for 2023-2029, the Concept for the Transition to a Green Economy (2013), and the Environmental Code of the Republic of Kazakhstan (2021). Collectively, these documents emphasize the importance of sustainable development, environmental awareness, and the integration of innovative technologies into education. In his 2021 State of the Nation Address, President Kassym-Jomart Tokayev underscored the national importance of environmental consciousness, stating that “environmental education must become an integral part of the national mindset and the foundation of a sustainable future”. This policy vision reinforces the need to embed ecological literacy, digital competence and interdisciplinary approaches within the structure of biological education and teacher training programs. Consequently, the improvement of biological and pedagogical education in Kazakhstan is not only a disciplinary requirement but also a strategic imperative aimed at forming educators capable of nurturing environmental responsibility and applying innovative, digitally enhanced methodologies in teaching.

Kazakhstan and Turkey, while developing pedagogical biological education within different historical and cultural contexts, face similar challenges: limited opportunities for laboratory and field training, the predominance of theoretical teaching methods and the need to introduce innovative pedagogical practices.

Based on a comparative analysis of pedagogical universities in Kazakhstan and the Faculty of Biological Sciences at Hacettepe University (Turkey), the study focuses on identifying similarities and differences in curricula, teaching methods and the level of students’ practical training in the disciplines Zoology and Animal Diversity. To achieve this aim, the study defines the following objectives:

- to identify and substantiate the key characteristics of teaching animal diversity in biology teacher education programs based on student survey results;
- to compare traditional and innovative teaching approaches, including project-based, research-oriented and digital methods applied in Kazakhstan and Turkey;
- to determine the role of laboratory and field practices in the formation of practical, research and environmental competencies of future biology teachers;
- to propose an exemplary lesson plan for teaching animal diversity by adapting effective research-based and digital practices of Turkish higher education to the educational context of Kazakhstan.

In Kazakhstan and Turkey, biological education is developed based on national standards; however, both countries – and especially Kazakhstan – face

similar methodological challenges: insufficient practical orientation of training, a weak material and technical base and limited use of digital tools. With the transition toward digital education and growing international integration, improving the methodological foundations for studying animal diversity has become an urgent task. A comparative analysis of pedagogical approaches in Kazakhstan and Turkey makes it possible to identify the most effective methods and technologies applied in the training of biology students.

In comparison with international practice (Finland, South Korea, Japan, the United States) [1-3], where digital laboratories, augmented reality microscopy and project-based learning are widely implemented, the Kazakhstani and Turkish models remain predominantly traditional.

However, the introduction of AR/VR technologies, digital simulators and multimedia resources into biology education demonstrates positive dynamics. These methods help compensate for the lack of physical laboratory opportunities and contribute to the development of students' skills in scientific observation, analysis and animal classification.

A methodologically effective model is considered to be a combined approach that includes:

- laboratory experiments and observations;
- field practice and excursions;
- the use of digital technologies (virtual laboratories, video materials, 3D-models);
- independent mini-projects and research assignments [4].

Based on a comparative study conducted at pedagogical universities in Kazakhstan and the Faculty of Biological Sciences at Hacettepe University (Turkey), the research aims to identify similarities and differences in curricula, pedagogical methods, and the level of students' practical training in zoology and animal diversity courses.

### **Materials and methods**

The research is based on a survey conducted among 25 students in Turkey enrolled in pedagogical universities in the field of «Biology». The purpose was to identify the teaching methods used, the degree of implementation of innovative technologies and to assess the impact of practical training on the development of professional competencies. The methodological framework includes:

- analysis of pedagogical sources and curricula;
- quantitative and qualitative analysis of survey data;
- comparative analysis of Kazakhstani and Turkish experiences;
- generalization of empirical results to develop methodological recommendations.

The questionnaire contained 10 questions covering key aspects of biological education: forms of instruction, the role of the teacher, use of technologies, the effectiveness of practical classes, and assessment of students' readiness for professional activity. *Methods of analysis:*

1. Analysis of the content of courses and practical sessions related to the topic “Animal Diversity”.
2. Comparison of teaching materials and pedagogical technologies used in the learning process.
3. Student surveys focusing on the effectiveness of teaching methods, motivation, and the level of practical skills.
4. Interviews with teachers regarding challenges and innovations in teaching.

The collected data were systematized into comparative tables reflecting the differences in approaches to studying animals and forming practical competencies.

### Results

The survey analysis conducted in Turkey revealed several key trends in biological education. The findings indicate a clear predominance of university-based biological training (72%) and a strong orientation toward laboratory and experimental learning, as evidenced by high levels of student involvement in laboratory work (80%) and experimental research (68%). At the same time, the results demonstrate a growing integration of digital technologies into zoological education, with 60% of respondents reporting the use of video lectures and AR/VR tools and 44% employing educational animation software. These results provide an empirical basis for further comparative analysis of pedagogical approaches to teaching animal diversity (Table 1).

Table 1. Synthesis of Survey Results (Turkey)

<i>Aspect</i>	<i>Results (%)</i>
Forms of knowledge acquisition	University studies – 72%; School education – 28%
Teaching methods	Laboratory work – 80%; Experimental research – 68%; Visual/animated materials – 76%; Predominantly theoretical lessons – 28%
Role of the teacher	Active guidance – 48%; Sufficient but unsystematic support – 40%
Use of digital technologies	Video lectures & AR/VR – 60%; Educational animation software – 44%; Mobile applications – 24%
Forms of assessment	No clear assessment system – 40%; Observational/LMS-based assessment – 20%
Study of animals	School lessons – 48%; University laboratory research – 20%; Field practice – 8%
Main challenges	Insufficient material-technical base – 36%; Lack of time & overloaded curricula – 24%
Most effective methods (students' view)	Laboratory classes – 68%; Field studies – 60%; Project-based/practice-oriented learning – 48%

Overall, according to students, the most effective learning formats are laboratory classes (68%), field studies (60%), and project-based, practice-oriented approaches (48%).

1. *Content of Educational Materials.* In Turkish academic courses (for example, in the *Zoology and Animal Diversity* program at Hacettepe University), considerable attention is devoted to evolutionary systematics, ecology, animal behavior, and the anatomical and physiological characteristics of species. Each section includes both laboratory and field assignments – from the analysis of microscopic specimens to observations in natural habitats.

In Kazakhstani pedagogical universities, the courses also include sections on the systematics and morphology of animals; however, theoretical instruction still predominates. Practical sessions are often limited to the demonstration of prepared specimens or multimedia materials (Table 2).

Table 2. Comparative Analysis of Zoology Course Content in Kazakhstan and Turkey

<i>Parameter</i>	<i>Turkey (Hacettepe)</i>	<i>Kazakhstan</i>
Volume of laboratory work	60% of the course	30% of the course
Field practice	Annually (2-3 weeks)	Occasional
Integration of digital resources	AR/VR models, digital collections	Multimedia and presentations
Interdisciplinarity	Ecology, genetics, behavior	Morphology and classification
Focus of content	Evolution, behavior, ethics	Classification and morphology

Nevertheless, in recent years, there has been a growing trend toward the implementation of problem-based learning and digital simulations, particularly within courses such as Vertebrate Zoology and Biology Teaching Methods (Figure 1).

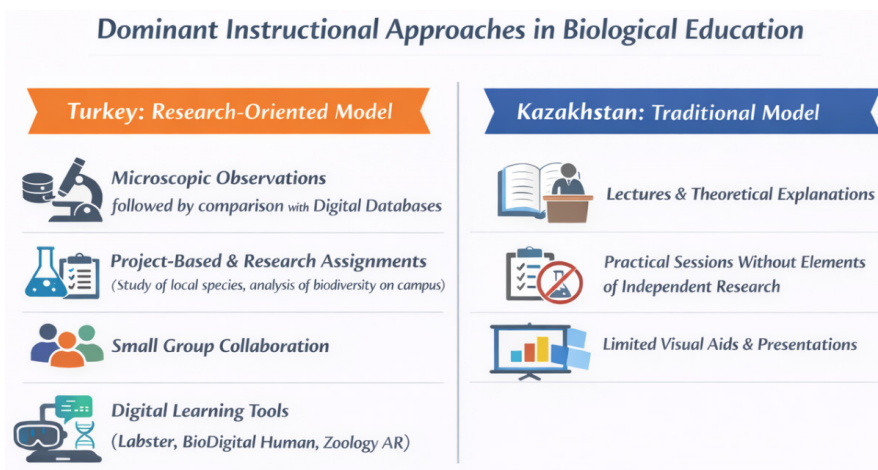


Figure 1 – Dominant pedagogical methods: a comparative overview of Turkey and Kazakhstan

2. *Effectiveness of Methodological Approaches* (based on survey results). The analysis of student feedback and curriculum observations revealed that the Turkish model of pedagogical education, exemplified by Hacettepe University, demonstrates higher effectiveness in developing research and practical competencies compared to the Kazakhstani model, which remains more theoretically oriented [5-7]. Turkish universities actively integrate digital tools (AR/VR, Labster simulations), project-based tasks and continuous formative assessment, while Kazakhstani institutions rely largely on traditional instruction and summative evaluation. These differences affect students' engagement, motivation and their ability to apply biological knowledge in pedagogical contexts (Table 3).

Table 3. Comparative effectiveness of methodological approaches in teaching Animal Diversity

<i>Criterion</i>	<i>Turkey (Hacettepe)</i>	<i>Kazakhstan</i>
Effectiveness of active methods	78% of students rate them as highly effective	45% of students report moderate effectiveness
Level of practical skills	High (work with live and digital specimens)	Moderate (mainly theoretical basis)
Participation in research and field projects	70% of students	35% of students
Use of interactive technologies	65% of teachers	30% of teachers
Student engagement	High (group projects, presentations)	Moderate (individual work)

Thus, the results show that the Turkish model of zoology education provides a higher level of students' practical and research training due to the use of active learning methods and constant interaction with the natural environment. The comparative analysis revealed that the differences between the Kazakhstani and Turkish models are not limited to material resources but are also rooted in the philosophy of teaching.

In Turkey (particularly at Hacettepe University), biological education is based on a research-oriented paradigm in which the student is an active participant in discovery rather than a passive listener [8]. Laboratory work, field studies, and participation in university research projects help students develop sustainable practical competencies, critical thinking, and the ability to apply knowledge in practice [9]. In Kazakhstan, the traditional system remains strong; however, elements of the STEM approach [10], digital laboratories, and environmental practicums are increasingly being integrated. Nevertheless, the reliance on theoretical lectures and the limited number of field practices constrain the development of students' observation, analytical, and animal classification skills.

In both contexts – Kazakhstan and Turkey – special importance is placed on training educators capable of using modern pedagogical technologies and scientific methods effectively. Based on the results of the comparative analysis, a methodological framework was developed that combines the research-based, digital and practice-oriented components of zoological education. This approach integrates active learning, AR/VR virtual laboratories and project-based methods – reflecting the best practices of Hacettepe University (Turkey) while adapting them to the educational realities of Kazakhstani pedagogical universities.

The proposed lesson plan illustrates how the methodological foundations of teaching animal diversity can be implemented in higher education. The lesson is designed for 50 minutes and focuses on developing students' practical, digital and research competencies through interactive learning environments such as *Labster* and *Zoology AR*.

The methodological basis of the lesson rests on the following key principles:

1. Inquiry-based learning – students act as researchers exploring biological diversity through observation and experimentation.
2. Digital transformation of education – use of AR/VR and simulation platforms to visualize anatomy and animal adaptations.
3. Interdisciplinary integration – linking zoology with ecology, genetics, and pedagogy.
4. Collaborative learning – teamwork and group discussions to enhance communication and analytical skills.
5. Reflective assessment – students evaluate their learning outcomes through digital forms and self-assessment [11].

This model allows future biology teachers to not only understand the diversity of animals theoretically, but also to experience the process of scientific discovery, applying knowledge through digital and experimental tools – thus forming the core of modern methodological competence in biological and pedagogical education.

*Lesson Plan. Topic: Adaptations and Diversity of Vertebrates (duration: 50 minutes).* Teaching Model: Research-based and interactive (adapted from Hacettepe University, Turkey). Learning Objectives:

- to explore examples of animal adaptations to various environments using digital and interactive methods;
- to develop students' scientific thinking and observational skills through virtual laboratory experiences;
- to apply research-based and project-oriented approaches to studying animal anatomy and ecology.

Competencies Developed: *a) Practical:* Observing and describing morphological and ecological adaptations. *b) Digital:* Using virtual laboratories and AR/VR tools to study biological systems. *c) Research:* Collecting, analyzing, and interpreting biological data. *d) Communicative:* Collaborating in teams and presenting scientific findings.

Required Tools and Resources:

- Laptops or tablets with internet access

- *Virtual laboratory platform: Labster Zoology Simulation or Zoology AR*
- *Multimedia video: “Animal Adaptations in Nature” (5 minutes)*
- *Google Docs or LMS (for recording observations and assessment)*
- *Projector and screen for group discussion (Table 4-6).*

Table 4. Lesson Structure (50 minutes)

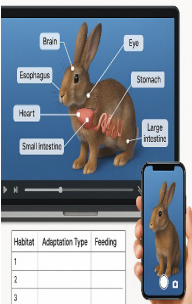
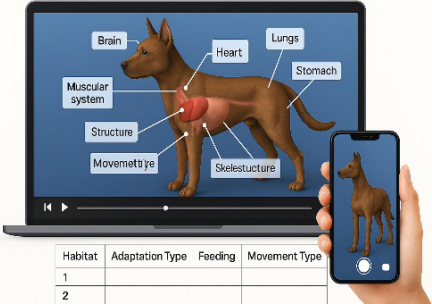

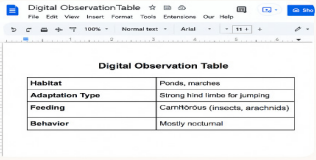
Stage	Duration	Activities
<i>Introduction and Motivation</i>	5 min	Teacher introduces the topic and learning goals. Students answer an activating question: “ <i>Why do some animals survive while others become extinct?</i> ”
<i>Warm-Up Video</i>	5 min	Watch the video “ <i>Animal Adaptations in Nature</i> ”. Short class discussion: <i>Which examples of adaptation did you notice?</i>
<i>Virtual Laboratory Activity</i>	25 min	<p>Students work in 3 groups:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Group 1: Studies respiratory adaptations in fish.</li> <li><input type="checkbox"/> Group 2: Analyzes amphibian movement and environmental behavior.</li> <li><input type="checkbox"/> Group 3: Examines wing structure and flight in birds.</li> </ul> <p>In Labster / Zoology AR, students:</p> <ul style="list-style-type: none"> <li>– Rotate and explore a 3D model of an animal;</li> <li>– Observe organs and body systems;</li> </ul> <p>In Labster / Zoology AR:</p>   <p>– Take screenshots or short video clips;</p> <p>– Fill in a digital observation table in Google Docs (habitat, adaptation type, feeding, behavior).</p>  
<i>Group Discussion and Reflection</i>	10 min	Each group presents its findings (2–3 min). Teacher facilitates analysis and comparison: <ul style="list-style-type: none"> <li>– How does the environment influence morphology?</li> <li>– What are common features among species?</li> <li>– Which adaptations are most efficient for survival?</li> </ul>
<i>Evaluation and Feedback</i>	5 min	Students complete a short Google Form: “ <i>What did I learn today?</i> ” and “ <i>How did virtual labs help me understand the topic?</i> ” Teacher gives brief verbal feedback and summarizes the key takeaways.

Table 5. Assessment Criteria

<i>Criterion</i>	<i>Max Points</i>
Active participation in virtual lab	5
Analysis and interpretation of findings	5
Use of digital tools (AR/VR, simulation)	3
Quality of group presentation	2
<i>Total:</i>	<i>15 points</i>

*Homework.* Create a short digital poster or infographic on “*Animal Adaptations in the Ecosystems of Kazakhstan*” using Canva or PowerPoint (1-2 slides).

Table 6. Pedagogical Integration (based on Turkish Model)

<i>Turkish Approach</i>	<i>Adaptation for Kazakhstan</i>
Project-based learning	Mini research in small groups
Digital zoology tools (AR/VR)	Labster or Zoology AR simulations
Field observation component	Campus-based biodiversity microproject
Student-centered methodology	Students as researchers and presenters
Reflection-based assessment	Google Form and self-evaluation feedback

Overall, the study confirms that the effectiveness of teaching about “*Animal Diversity*” depends on methodological principles that integrate research activity, digital tools and practical orientation.

Based on the comparative analysis, a methodological framework and a lesson plan (“*Adaptations and Diversity of Vertebrates*,” 50 minutes) were developed, reflecting best practices from the Turkish experience and adapted to the educational context of Kazakhstan. This model integrates active learning, virtual laboratories and project-based methods, enabling students not only to acquire zoological knowledge but also to engage in the process of scientific discovery. Thus, the proposed methodological system contributes to the development of:

- professional and research competencies;
- digital literacy and the ability to use educational technologies;
- ecological and analytical thinking among future biology teachers.

In conclusion, the results of this study can serve as a scientific and practical foundation for developing new teaching and methodological complexes and digital laboratory practicum modules in zoology, aimed at modernizing biological education in Kazakhstan and strengthening its research and ecological orientation.

## Discussion

This comparative study offers new insights into how zoological education in pedagogical universities is shaped not only by curriculum content but also by the methodological and pedagogical strategies embedded within it. While earlier works (Akyol, 2019 [12]; Uğurlu, 2020 [13]; Kenzhebekova, 2018 [14]; Tüysüz & Çakmak, 2021 [15]) have discussed theoretical differences in biological education systems between Kazakhstan and Turkey, the present research

contributes empirical evidence that connects teaching methodology, practical training, and students' professional competence development.

Previous studies in Turkey, particularly those conducted at Hacettepe University and Gazi University (Akyol, 2019; Demir & Tüysüz, 2020), emphasized that active, research-based, and laboratory-centered teaching methods significantly enhance students' understanding of animal diversity and promote scientific inquiry skills. Similarly, in Kazakhstan, researchers such as Kenzhebekova (2018) and Zhumanova (2021) have highlighted the need to integrate fieldwork and experimental practice into biological education to bridge the gap between theoretical learning and pedagogical application. However, these works remained largely descriptive and lacked comparative empirical validation.

The findings of the present study provide quantitative and qualitative evidence that the effectiveness of studying animal diversity depends not merely on the inclusion of zoological topics in curricula, but on the pedagogical approaches employed to teach them. This aligns with Vygotsky's social constructivism, emphasizing socially contextualized and collaborative learning and Bruner's spiral curriculum theory, which supports gradual and experiential knowledge acquisition.

The Turkish model, exemplified by Hacettepe University, reflects these theories using project-based learning, field observations, and the integration of digital laboratory technologies. These methods enable students to move beyond passive memorization, fostering critical thinking, research autonomy, and practical scientific skills. As a result, biology students demonstrate stronger engagement with real-world zoological phenomena and higher levels of professional readiness.

In contrast, the Kazakhstani pedagogical model still largely relies on lecture-based and theoretical instruction. Although laboratory work and zoological taxonomy are part of the curriculum, the frequency of experimental or field-based learning remains low. As noted by Bekturova and Kenzhebekova (2020), the insufficient emphasis on applied research in zoology limits students' ability to develop hands-on scientific and teaching competencies. This approach diverges from international standards in biological education reform, including the European Higher Education Area (EHEA) framework and UNESCO's Education for Sustainable Development (ESD) principles, which stress action-oriented, inquiry-based, and experiential learning.

The uniqueness of the present study lies in its systematic comparative analysis of zoological teaching methodologies and practices between two national pedagogical systems – Kazakhstan and Turkey. Unlike prior theoretical discussions, this research incorporates survey data, course content analysis, and empirical evaluation of student engagement and skill formation. The results show that the structure of laboratory and field learning directly influences students' mastery of biological diversity concepts and their ability to apply knowledge in pedagogical practice.

The practical significance of this study lies in its potential to:

- reform zoology curricula in Kazakhstan through the inclusion of research-oriented and project-based modules;

- develop integrated laboratory manuals and digital zoological collections;
- create teacher training programs focused on active and student-centered learning methodologies;
- promote international collaboration between Kazakhstani and Turkish universities for methodological exchange.

Moreover, the study identified several systemic challenges that impede the development of effective zoological education in Kazakhstan: limited access to modern laboratory facilities, lack of field-based teaching opportunities and insufficient preparation of teachers to use innovative pedagogical methods. Addressing these barriers requires a comprehensive national strategy from updating university curricula to strengthening partnerships with institutions such as Hacettepe University, which successfully integrates active research and technological tools into zoological education.

Thus, the value of this research lies both in its scientific contribution to understanding cross-national pedagogical methodologies in zoology and its practical implications for reforming biological education in Kazakhstan. Based on a comparative and empirically grounded approach, the study provides recommendations relevant not only to these two countries but also to other regions seeking to modernize teacher education in the biological sciences and to promote a deeper, practice-oriented understanding of animal diversity.

### **Conclusion**

The research conducted showed that the methodological foundations for studying animal diversity should be based on a balanced integration of theoretical knowledge and practical forms of learning.

*In conclusion*, the experience of Turkey – particularly Hacettepe University – demonstrates that active teaching methods, such as project-based learning, field practice, digital simulations and group collaboration, significantly increase student engagement and improve the quality of professional preparation.

To enhance the methodology of teaching zoological disciplines in Kazakhstan, the following *recommendations* are proposed:

1. Expand laboratory and field sessions, providing students with modern equipment and digital resources.
2. Introducing project- and research-oriented learning formats that promote student independence and inquiry-based activity.
3. Utilize AR/VR technologies and digital animal models to improve visualization and engagement.
4. Strengthen teacher professional development through international training programs, for example, in collaboration with Hacettepe University.
5. Integrate an interdisciplinary approach that connects zoology with ecology, genetics, and pedagogy.

Thus, the comparative analysis has demonstrated that the integration of Turkish experience and active learning methods can significantly contribute to developing in Kazakhstani biology students a deeper understanding of the animal world and stronger practical skills essential for future pedagogical work.

In continuation of this research, it is planned to develop a mobile application “Zoology Practice+”, which will include interactive lesson plans, AR/VR-based laboratory simulations, and methodological modules adapted from the Turkish experience and tailored to the Kazakhstani educational context. This digital tool will support teachers and students in implementing modern, practice-oriented approaches to studying animal diversity in biological education.

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## **ПЕДАГОГИКАЛЫҚ БАҒЫТТАҒЫ БИОЛОГ-СТУДЕНТТЕРГЕ ЖАНУАРЛАРДЫҢ АЛУАНТҮРЛІЛІГІН ЗЕРТТЕУДІ ОҚЫТУДЫҢ ӘДІСНАМАЛЫҚ НЕГІЗДЕРІ**

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**Аңдатпа.** Бұл мақалада педагогикалық бағыттағы биология мамандығының студенттеріне жануарлар дүниесінің әртүрлілігін зерттеуді оқыту әдістемесінің негіздері қарастырылады. Жануарлар әлемін зерттеуді оқыту болашақ биология мұғалімдерінің ғылыми ойлауын, тірі табиғатқа жанашырлық пен экологиялық жауапкершілікті қалыптастыруда маңызды рөл атқарады. Сондықтан биологиялық білім беруді заманауи экологиялық және цифрлық талаптарға сәйкестендіру қажеттілігімен зерттеудің өзектілігі айқындалады. Зерттеу жұмысының мақсаты – Қазақстан мен Түркияның (Хаджеттепе университеті мысалында) педагогикалық бағыттағы білім беру жүйелерін салыстыра отырып, жануарлар алуантүрлілігін оқытудағы әдістемелік тәсілдерді, тиімді педагогикалық технологияларды және практикалық даярлық деңгейін айқындау. Зерттеу барысында Хаджеттепе университетінің студенттері мен бірнеше оқытушыдан сауалнама мен сұхбат алынып, оқу бағдарламалары мен практикалық сабақтардың мазмұны талданды. Нәтижелер көрсеткендей, Түркия университеттерінде, әсіресе Хаджеттепе университетінде, зерттеушілік және интерактивті оқыту әдістері (жобалық жұмыс, зертханалық және далалық тәжірибелер) кеңінен қолданылады. Тек түрік тарапынан алынған деректермен шектелмей, Қазақстандағы педагогикалық жоғары оқу орнының биология мамандығы студенттері арасында да сауалнама жүргізілді. Қазақстандық сауалнама

нәтижелері студенттердің практикалық сабақтарға деген қызығушылығы жоғары болғанымен, зертханалық және далалық жұмыстардың жеткіліксіздігін көрсетті. Қазақстандық жоғары оқу орындарында дәстүрлі теориялық оқыту басым болғанымен, соңғы жылдары проблемалық оқыту және цифрлық модельдер енгізілуде. Сонымен қатар, студенттердің көпшілігі экожүйелер мен жануарлар дүниесін зерттеу барысында цифрлық құралдарды (виртуалды зертханалар, биологиялық модельдеу платформалары) қолдану қажеттілігін атап өтті. Бұл тәсіл студенттердің белсенділігін және практикалық құзыреттерін арттырады. Осымен байланысты, Түркияның озық тәжірибелерін Қазақстанның жоғары оқу орындарының ерекшеліктеріне бейімдей отырып, жануарлар әртүрлілігін зерттеуді оқытуға арналған сабақ жоспарлары мен әдістемелік ұсыныстар әзірленді. Зерттеу қорытындысы бойынша жануарлар алуан түрлілігін оқытудың тиімділігі тек мазмұнға емес, оны жүзеге асыру әдістемесіне байланысты екені анықталды. Зертханалық және далалық сабақтарды кеңейту, заманауи цифрлық құралдарды енгізу, пәнаралық тәсілді қолдану және оқытушылардың кәсіби біліктілігін халықаралық деңгейде арттыру қажеттілігін атап өтті.

**Тірек сөздер:** Педагогикалық білім беру, биологиялық білім беру, оқыту әдістемесі, жобалық оқыту, практикалық құзыреттілік, биологиялық алуантүрлілік, жануарлар дүниесі, цифрлық технология

## **МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ОБУЧЕНИЯ БИОЛОГОВ-СТУДЕНТОВ ПЕДАГОГИЧЕСКОГО НАПРАВЛЕНИЯ ИЗУЧЕНИЮ РАЗНООБРАЗИЯ ЖИВОТНЫХ**

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**Аннотация.** В данной статье рассматриваются методологические основы преподавания изучение разнообразия животного мира студентам биологических специальностей педагогического направления. Обучение исследованию животного мира играет важную роль в формировании у будущих учителей биологии научного мышления, бережного отношения к живой природе и экологической ответственности. Актуальность исследования определяется необходимостью приведения биологического образования в соответствие с современными экологическими и цифровыми требованиями. Цель исследования – определить методические подходы, эффективные педагогические технологии и уровень практической подготовки при обучении разнообразию животных на основе сравнительного анализа педагогических систем Казахстана и Турции (на примере Хаджеттепе университета). В ходе исследования были проведены анкетирование и интервью среди студентов и преподавателей Хаджеттепе университета, также проанализированы учебные программы и содержание практических занятий. Результаты показали, что в турецких университетах, особенно в

Хаджеттепе, широко применяются исследовательские и интерактивные методы обучения – проектная деятельность, лабораторные и полевые практики. При этом исследование не ограничивалось турецким опытом: аналогичные опросы были проведены среди студентов педагогических вузов Казахстана, обучающихся по направлению «Биология». Итоги казахстанского анкетирования показали, что при высоком интересе студентов к практическим занятиям количество лабораторных и полевых работ остаётся недостаточным. Несмотря на преобладание традиционного теоретического обучения, в последние годы в казахстанских вузах постепенно внедряются проблемное обучение и цифровые модели. Большинство студентов отметили необходимость активного использования цифровых инструментов – виртуальных лабораторий, платформ биологического моделирования – при изучении экосистем и животного мира. Эти подходы повышают учебную активность и развивают практические компетенции студентов. В связи с этим, адаптируя передовой опыт Турции к особенностям казахстанских высших учебных заведений, были разработаны учебные планы и методические рекомендации по преподаванию курса, посвящённого изучению разнообразия животных. По результатам исследования установлено, что эффективность преподавания разнообразия животного мира зависит не только от содержания, но и от используемых методик обучения. Отмечена необходимость расширения лабораторных и полевых занятий, внедрения современных цифровых инструментов, применения междисциплинарного подхода и повышения профессиональной квалификации преподавателей на международном уровне.

**Ключевые слова:** Педагогическое образование, биологическое образование, методика преподавания, проектное обучение, практическая компетентность, биологическое разнообразие, животный мир, цифровые технологии

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