EFFECTIVENESS OF PEDAGOGICAL METHODS FOR DEVELOPING ECOLOGICAL COMPETENCIES AMONG UNIVERSITY STUDENTS IN BIOLOGY EDUCATION

Aliyeva Makhfuza Abdujabborovna
Biology Lecturer, Angren University

ABSTRACT

This article analyzes the pedagogical foundations for developing students' ecological competencies in the process of biology education, as well as the effectiveness of modern educational methods. The study highlights the content of environmental education, the role of biology in fostering an ecological culture, and the didactic potential of a competency-based approach. It also provides a scientific and pedagogical justification for the impact of using the comparative method, problem-based learning, project-based activities, observation, and interactive methods on the development of students' ecological knowledge, skills, and competencies. The research employed methods such as the analysis of scientific and pedagogical literature, comparative analysis, observation, generalization, and a systems approach. The findings revealed that applying modern pedagogical methods in biology lessons promotes the development of students' ecological thinking, a conscientious attitude toward nature, and an ecological culture. Based on the research results, scientific and practical recommendations were formulated to enhance the effectiveness of developing ecological competencies within the biological education process.

Keywords: Biology education, ecological competence, environmental education, ecological culture, pedagogical methods, competency-based approach, interactive learning, biology lessons, ecological thinking, sustainable development.

INTRODUCTION

Today, the globalization of risk factors, the reduction of biological diversity, climate change, the need to manage natural resources, and environmental pollution have made environmental education one of the priority areas of modern education. To promote sustainable development, it is important to cultivate individuals who possess ecological knowledge, ecological thinking, and ecological competencies. Therefore, developing students' ecological competencies while teaching the general biology school course is one of the most critical pedagogical tasks.

Biology, as the fundamental science studying living organisms, their habitats, and their specific interrelationships in nature, holds great potential for shaping an ecological worldview. Through this discipline, students learn to value nature and recognize the impact of human activity on the environment; they also develop environmental responsibility and skills for an eco-friendly lifestyle. In biology lessons, theoretical information must be reinforced by practical activities, ensuring the effective assimilation of ecological knowledge and, as a result, the rapid formation of ecological competencies.

The widespread adoption of a competency-based approach in the modern education system requires the enhancement of pedagogical methods for teaching biology. The use of modern

software, methodologies, research activities, STEAM technologies, field observations, educational tools, and interactive methods all serve as factors in developing students' ecological thinking, independent judgment, and the formation of a scientific approach to solving environmental problems.

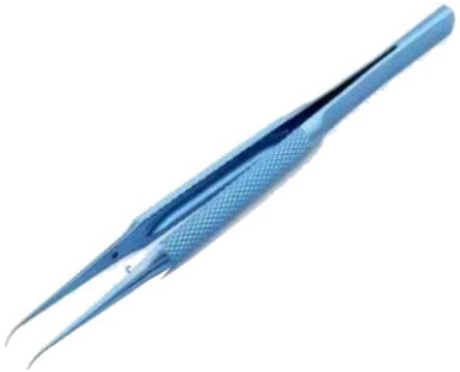
From this perspective, identifying and substantiating effective pedagogical methods for forming ecological competencies in biology instruction, implementing them into the educational process, and improving mechanisms for developing students' ecological culture are among the most pressing scientific and practical tasks of modern pedagogy. This study aims to analyze and develop pedagogical methods that foster the development of ecological competencies in biology lessons, as well as to formulate scientific recommendations for their implementation.

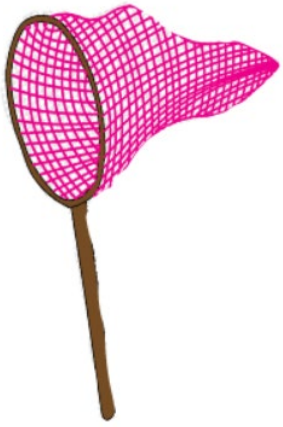
Modern children have ever-increasing opportunities to spend time in the digital world rather than among plants, animals, and in nature, and the number of young people who prefer doing so is also growing. This is why psychologists are now talking about "nature deficit disorder." As this alienation from nature grows, students develop problems such as an inability to distinguish between plants, recognize animals, or take an interest in learning about them. Consequently, in an educational context, this leads to nature not being perceived as valuable, which in turn fosters the idea that its destruction is permissible.

Whereas in biology education it was once traditional to study animal anatomy and the adaptations of their organs for various functions—comparing them to the structure and function of different instruments and devices and explaining that the creation of these instruments was also a result of observing nature—now the opposite is true. It has become necessary to use comparisons with the structure of instruments and devices, which are more familiar to students, in order to convey information about animals and their anatomy.

Observations show that in the past, students, thanks to their life experience, possessed a wealth of information about the appearance, general structure, and common species of animals. Consequently, zoology lessons utilized various methods aimed at systematizing and reinforcing this knowledge. For example, very rich didactic materials based on a comparative approach were developed for zoology lessons: the structure of birds' beaks was studied in relation to their diet, and the structure of their legs was studied in connection with their lifestyle and method of locomotion. Knowing that the structure of birds' beaks varies, the comparative method was used to accurately understand the reasons for such adaptations. Now, however, due to students' lack of personal experience and knowledge about the structure and species of birds, it has become necessary to first provide them with this information. In this regard, it is advisable to use tools and implements familiar to students from their daily lives as a deductive basis for the comparative method.

Table 1.Studying the structure and function of birds' beaks in comparison with various tools and implements

 Hammer	 Sparrow Short and powerful beaks adapted for eating seeds
 Jackhammer	 Woodpecker A beak adapted for piercing and breaking open tree bark.
 Tweezers (forceps)	 The thin, long, pincer-like beak of the hoopoe

 Curved tweezers	 The proboscis of a bee
 Drinking straw	 The tubular beak of a hummingbird, adapted for sucking nectar
 Butterfly net	 At the swallow The beak is short and opens wide, which allows it to catch flies and mosquitoes in the air.

 A spade for removing weed roots  Drill bit	 The crossbill's beak, which helps extract seeds from cones
 Surgical scissors	 The curved, scissor-like beak of a scythebill

Cake tongs

Fishing net

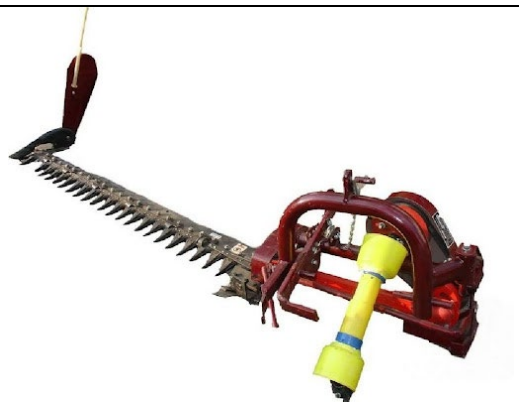
The spoonbill's beak, adapted for catching fish

Funnel

The funnel-shaped beak of a flamingo, adapted for catching small fish

Fishing trawler (drifter)

The pelican's beak, adapted for catching fish



Hay mower

The goose's beak, adapted for plucking grass

Tongs

Nutcracker

The parrot's beak, adapted for cracking seeds and nuts

Knife

The eagle's beak, adapted for tearing meat

The alienation of young people from nature also alienates humanity itself from it, and ultimately leads to catastrophe, since humanity is a part of nature and cannot survive without it. The task of a biology teacher is to teach students to appreciate how diverse the world around us is, to help them interact harmoniously with it, to draw their attention to the beauty and diversity of nature, and to explain the need for careful treatment of living organisms.

The extent to which the problem has been studied

Currently, the increasing complexity of problems and the rise of global diseases related to the environment challenge the education system to foster individuals who possess environmental

responsibility and a conscious attitude towards nature, resulting from well-developed ecological thinking. Biology plays an important role in achieving this goal, as this subject allows students to systematically and clearly acquire knowledge about living organisms, ecosystems, and the animal world.

However, in practice, the process of developing environmental competencies in biology lessons at general education schools is fraught with a number of problems. In the classroom, environmental knowledge is conveyed primarily as theoretical information, with insufficient attention paid to students' practical activities, independent work, research-based observation, and physical activity. Although students master the theoretical foundations, their ability to apply this knowledge in real-life situations, demonstrate environmental responsibility, and make environmentally sound decisions is not sufficiently developed.

Furthermore, modern pedagogical technologies, software, curricula, research methods, and systems of interdisciplinary integration are not applied at a uniformly high level across all educational processes. This reduces the quality of environmental education and limits opportunities for enhancing students' environmental literacy.

This situation creates an urgent need to develop and widely implement scientific and pedagogical methods for monitoring environmental competencies within the biology curriculum. This specific problem defines the scientific focus of the research and contributes to the methodology of biology education.

Purpose of the Study

The purpose of this study is to develop a modern scientific and methodological framework for fostering students' environmental competencies in the process of teaching biology, as well as practical recommendations aimed at improving the quality of education, cultivating an environmental culture, promoting ecological thinking, and encouraging a responsible attitude toward nature.

Research Methods

This study employed a qualitative conceptual research design based on a systematic review and comparative analysis of scientific literature related to environmental education, ecological competence, and biology teaching. National policy documents, international reports, and peer-reviewed scientific publications were analyzed to identify effective pedagogical approaches for developing ecological competencies among university students.

The study used document analysis, comparative analysis, content analysis, synthesis, and generalization as its principal research methods. Scientific publications indexed in international databases, UNESCO and OECD policy documents, and contemporary studies on environmental education served as the primary sources for analysis. The collected information was classified into thematic categories to identify common pedagogical strategies, methodological trends, and practical implications for biology education.

The conceptual framework of the study was developed through the integration of competency-based education, environmental education, and constructivist learning approaches.

Data Analysis

The collected literature and documentary sources were analyzed using qualitative content analysis and thematic synthesis. Similar pedagogical concepts were grouped into categories related to ecological competence development, interactive teaching strategies, competency-based education, and environmental responsibility. Comparative analysis was used to identify similarities and differences among existing pedagogical approaches, while synthesis enabled the formulation of an integrated conceptual framework for improving biology education.

Conceptual Analysis of Effective Pedagogical Methods

The analysis of contemporary scientific literature demonstrates that ecological competence is a multidimensional construct encompassing ecological knowledge, environmental responsibility, critical thinking, sustainable behavior, and practical problem-solving skills. Recent studies consistently indicate that biology education provides one of the most appropriate educational contexts for fostering these competencies because it enables students to understand the relationships between living organisms, ecosystems, and human activities.

The reviewed publications emphasize that competency-based biology education should move beyond the transmission of theoretical knowledge and incorporate active learning strategies. Interactive teaching methods, inquiry-based learning, project-based activities, outdoor observations, laboratory investigations, and collaborative discussions were identified as the most effective pedagogical approaches for improving students' ecological awareness and responsible environmental behavior.

Comparative teaching methods also demonstrate considerable educational value. The comparison of biological structures with familiar technical devices enables students to understand biological adaptations through analogical reasoning, thereby improving conceptual understanding and long-term knowledge retention. This pedagogical approach supports the development of analytical thinking and facilitates meaningful learning.

Furthermore, the literature indicates that digital technologies, multimedia resources, and virtual environmental simulations can complement traditional biology instruction by increasing students' engagement and providing opportunities to investigate ecological problems in authentic learning environments. The integration of these educational technologies contributes to the development of ecological literacy and sustainable thinking.

Overall, the reviewed evidence suggests that combining competency-based instruction with interactive pedagogical methods and authentic environmental experiences provides an effective framework for strengthening ecological competencies among university students studying biology.

Conclusion

This study is dedicated to enhancing the effectiveness of modern pedagogical methods for developing and monitoring environmental competencies in biology education. The combination of methods such as comparison, problem-based learning, active games, practical lessons, and interactive exercises helps to deepen students' environmental knowledge, develop their ecological thinking, and foster a conscious attitude toward nature.

In this research, comparing biological objects with technical devices and everyday

instruments contributes to the comprehensive development of students. Practical assignments and observations are among the key factors in monitoring environmental competencies.

To develop environmental competencies in biology education, it is necessary to widely integrate innovative pedagogical technologies based on a competency-oriented approach, as well as computer-based tools and active teaching methods, into the educational process. Under these conditions, this approach serves to enhance students' environmental culture and helps them apply useful knowledge in their lives to conserve and rationally use natural resources.

One future area of scientific research is the experimental and practical development of environmental competencies in biology instruction, the creation of methodological guidelines for various age groups, and an in-depth study of the potential of educational technologies in environmental education. This will make a worthy contribution to fostering a responsible generation that will uphold the quality of biology education.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan No. PF-5729 of May 27, 2019. The Concept for the Development of Environmental Education in the Republic of Uzbekistan.
2. Resolutions of the Cabinet of Ministers of the Republic of Uzbekistan on Environmental Education and Sustainable Development. Tashkent, 2022.
3. UNESCO. Education for Sustainable Development: A Roadmap. Paris: UNESCO, 2020.
4. UNESCO. Greening Education Partnership. Paris: UNESCO, 2023.
5. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. New York: United Nations, 2015.
6. OECD. Education at a Glance 2023: OECD Indicators. Paris: OECD Publishing, 2023.
7. Hungerford H.R., Volk T.L. Changing Learner Behavior Through Environmental Education // Journal of Environmental Education. 1990. Vol. 21 (3). P. 8–21.
8. Palmer J.A. Environmental Education in the 21st Century: Theory, Practice, Progress, and Promise. London: Routledge, 1998.
9. Tilbury D. Environmental Education for Sustainability: Defining a New Focus of Environmental Education // Environmental Education Research. 1995. Vol. 1 (2). P. 195–212.
10. Stevenson R.B., Brody M., Dillon J., Wals A.E.J. International Handbook of Research on Environmental Education. New York: Routledge, 2013.
11. Ardoin N.M., Bowers A.W., Gaillard E. Environmental education outcomes for conservation. Biological Conservation. 2020. Vol. 241.
12. UNESCO. Reimagining Our Futures Together: A New Social Contract for Education. Paris: UNESCO, 2021.
13. United Nations Environment Programme (UNEP). Global Environment Outlook 6. Nairobi: UNEP.
14. Wals A.E.J. Sustainability-oriented education in the Anthropocene. International Review of Education. 2022.
15. Leicht A., Heiss J., Byun W.J. Issues and Trends in Education for Sustainable Development. UNESCO Publishing.
16. Rickinson M. Learners and Learning in Environmental Education: A Critical Review. Environmental Education Research.

17. Bybee R.W. The BSCS 5E Instructional Model and 21st Century Skills. Colorado Springs: BSCS.
18. Novikov, A.M. (2010). *Pedagogika* [Pedagogy]. Moscow: Egves.
19. Deryabo, S.D., & Yasvin, V.A. (1996). *Ekologicheskaya pedagogika i psikhologiya* [Environmental Pedagogy and Psychology]. Rostov-on-Don.
20. Ignatova, V.A. (1998). *Formirovanie ekologicheskoy kul'tury uchashchikhsya* [Formation of Students' Ecological Culture]. Tyumen.
21. Glova, T. (2010). Shkol'naya ekologicheskaya tropa i uroki estestvenno-nauchnogo tsikla [The school ecological trail and lessons in the natural science cycle]. *Shkol'noe planirovanie* [School Planning], (4), 88-100.
22. Glushchenko, O. (2010). Zavtra nachinaetsia segodnia: formirovanie ekologicheskoi kul'tury u detei [Tomorrow Begins Today: Fostering Environmental Culture in Children]. *Vospitatel'naia rabota v shkole* [Educational Work in School], (6), 44-52.
23. Deryabo, S. D., & Yasvin, V. A. (1996). *Ekologicheskaia pedagogika i psikhologiia* [Environmental Pedagogy and Psychology]. Rostov-on-Don. 480 p.
24. Ignatova, V. A. (1998). *Formirovanie ekologicheskoi kul'tury uchashchikhsia: teoriia i praktika* [Fostering Students' Environmental Culture: Theory and Practice]. Tyumen: Tyumen State University. 196 p.
25. Kelbas, R. V. (2008). Formirovanie kul'turno-ekologicheskikh stremlenii shkol'nikov v sisteme dopolnitel'nogo ekologicheskogo obrazovaniia posredstvom deiatel'nostnogo podkhoda [Fostering Cultural and Environmental Aspirations in Schoolchildren within the System of Supplementary Environmental Education through an Activity-Based Approach]. In *Fundamental'nye nauki i obrazovanie* [Fundamental Sciences and Education]. Biysk. 357 p.
26. Naumova, O. S. (2010). *Ideia vospitaniia ekologicheskoi kul'tury lichnosti shkol'nika kak dukhovno-nravstvennoi problemy v otechestvennoi pedagogike (konets XX — nachalo XXI vv.) * [The Idea of Fostering the Environmental Culture of a Student's Personality as a Spiritual and Moral Problem in Russian Pedagogy (Late 20th - Early 21st Centuries)]: A Monograph. Chita: Transbaikal State Humanitarian Pedagogical University Publishing House. 87 p.
27. Stromova, A. V. (2010). *Formirovanie ekologicheskoi kul'tury podrostkov v detsko-iunosheskikh obshchestvennykh ob"edineniiakh* [Fostering Environmental Culture in Adolescents within Children's and Youth Public Associations] (Candidate of Pedagogy Dissertation). Tambov. 207 p.
28. Tarakanova, L. R. (1995). *Stanovlenie ekologicheski gramotnogo povedeniia mladshikh podrostkov v turistsko-kraevedcheskoi deiatel'nosti* [The Development of Environmentally Literate Behavior in Young Adolescents through Tourism and Local Lore Activities] (Abstract of a Candidate of Pedagogy Dissertation). St. Petersburg: Herzen Russian State Pedagogical University. 18 p.
29. Bobonazarovna, F. S., & Abduhamidovich, N. A. (2021). Development of Mathematical Literacy in Chemistry Lessons. *European Scholar Journal*, *2* (3), 97-99.
30. Felten, P., Chick, N. L., & Finelli, C. J. (2023). The Principles of Good Practice in SoTL. Teaching & Learning Inquiry, 11, 1–15.
31. Simmons, N., Marquis, E., & Dawson, D. (2022). Scholarship of Teaching and Learning in Higher Education: Contemporary Perspectives. Teaching & Learning Inquiry, 10, 1–14.
32. Tight, M. (2023). Higher education research and the Scholarship of Teaching and Learning. Higher Education Research & Development, 42(5), 1093–1106.

33. Kreber, C. (2022). Transforming university teaching through the Scholarship of Teaching and Learning. Teaching in Higher Education, 27(8), 1181–1195.
34. Hutchings, P., Huber, M. T., & Ciccone, A. (2023). The Scholarship of Teaching and Learning Reconsidered. Jossey-Bass.
35. Poole, G., & Simmons, N. (2024). Developing evidence-informed university teaching through SoTL. Teaching & Learning Inquiry, 12, 1–17.
36. Freeman, S., et al. (2022). Active learning increases student performance in science education. Proceedings of the National Academy of Sciences.
37. UNESCO. (2024). Education for Sustainable Development Roadmap 2030. UNESCO Publishing.
38. OECD. (2023). The Future of Education and Skills 2030. OECD Publishing.
39. United Nations. (2023). Transforming Education Summit Report. United Nations