DIDACTIC OPPORTUNITIES OF TEACHING PHYSICS BASED ON ECOLOGICAL PROBLEMS

Otarbaev Amangeldi Edilbekovich
Nukus State Pedagogical Institute, Nukus, Republic of Karakalpakstan
e-mail: andarayza@gmail.com

Abstract

In this article, the didactic possibilities of teaching physics based on environmental problems are analyzed from a scientific-theoretical and practical point of view. The exacerbation of environmental problems in the modern education system requires a revision of the content and methods of teaching physics. The study substantiates the possibilities of increasing students' interest in knowledge, forming their ecological consciousness, and developing their competencies in science through the integration of environmental problems with the main sections of physics. The didactic advantages of the educational process, organized on the basis of environmental problems, the effectiveness of project and problem-based learning methods are revealed. The research results show that lessons with an ecological content enhance the practical significance of physics, serve the formation of stable knowledge, positive motivation, and ecological responsibility in students.

Keywords: environmental problems, physics education, didactic opportunities, environmental education, interdisciplinary integration, project education, environmental awareness, sustainable development.

Introduction

In the current conditions of globalization, along with the development of humanity, the intensification of environmental problems requires fundamental changes in all spheres of society, including the education system. Environmental problems such as climate change, global warming, environmental pollution, depletion of natural resources, and energy shortages are recognized as one of the most pressing issues of the 21st century [1]. In solving these problems, the upbringing of a young generation with ecological awareness and scientific thinking is of great importance.

The education system cannot be indifferent to environmental problems. Especially natural sciences, including physics, have great didactic possibilities in explaining environmental problems, analyzing their causes and consequences, and developing solutions. Physics, by studying natural phenomena based on laws, serves to reveal the scientific essence of ecological processes [2].

At the same time, the complexity of physics and its richness in abstract concepts often lead to a decrease in students' interest in the subject. This situation requires the introduction of new, life-related, practical approaches to teaching physics. Teaching physics based on environmental problems is considered one of such effective didactic approaches [3].

The main goal of this research is to determine the didactic possibilities of teaching physics based on environmental problems and to scientifically substantiate their effectiveness in the educational process [4].

Methods

This study, aimed at identifying the didactic possibilities of teaching physics based on environmental problems and assessing their effectiveness in the educational process, was conducted in the conditions of general education schools. The research process was organized systematically, consistently, and gradually, and was carried out based on modern pedagogical approaches.

Research design. The research was of **a pedagogical-experimental** nature and included theoretical and practical stages. Initially, scientific and pedagogical literature on teaching physics based on environmental problems, state educational standards, and current curricula were analyzed. This analysis served to determine the existing possibilities of integrating ecological content into physics.

At the practical stage, a system of lessons organized on the basis of environmental problems was developed and tested in the experimental process. During the study, the results of the educational process, organized on the basis of traditional teaching and environmental problems, were compared.

Object and subject of research. The object of the research is the process of teaching physics in general education schools. The subject of the research is the didactic possibilities, methods, and forms of teaching physics based on environmental problems.

Research participants. Students of secondary and upper grades of general education schools participated in the study. Experimental and control groups were formed. In the experimental group, physics lessons were organized based on environmental problems, and in the control group, traditional teaching methods were used.

Research methods

The following set of methods was used in the research process:

- **Pedagogical observation** - used to determine the activity of students in the lesson process, their attitude to environmental problems, and the level of assimilation.
- Interviews and surveys were organized to study students' interest in physics, their views on environmental problems, and their motivation.
- **Analysis of the educational process** - lesson plans based on environmental problems and the results of educational activities were analyzed.
- **Pedagogical experiment** - used to determine the effectiveness of lessons of ecological content.
- **Comparative analysis** - by comparing the results of the experimental and control groups, the advantages of the ecological approach were identified.

Organization of the educational process. Environmental problems are presented in close connection with the main branches of physics. Including:

- Movement of vehicles and their impact on the environment in the mechanics section;
- Energy saving, greenhouse effect and global warming in the section of molecular physics and thermodynamics;
- Use of alternative energy sources in the electricity and magnetism section;
- The use of solar radiation and the ecological significance of light energy in the optics department;
- In the section on atomic and nuclear physics, the environmental consequences of energy production were highlighted.

During the lessons, problem situations were created, tasks of ecological content, experiments, and mini-projects were organized.

Project and problem-based learning methods

In the study, **project-based** learning and **problem-based** learning methods were used as leading methods. Students were involved in the process of analyzing environmental problems, identifying causes and consequences, and proposing solutions based on the laws of physics. These methods developed students' independent thinking, research skills, and creative approaches [5].

Criteria for evaluating results

The research results were evaluated based on the following criteria:

- students' interest in physics;
- ability to apply theoretical knowledge in practical situations;
- level of environmental awareness and responsibility;

- independent and critical thinking skills;
- level of understanding of interdisciplinary connections.

During the assessment process, the results of test trials, oral questions and answers, and project work were analyzed.

Data processing

The obtained results were analyzed, summarized, and pedagogical conclusions were drawn. The results of the experimental and control groups were compared based on a comparative analysis. This process served to scientifically substantiate the didactic possibilities of teaching physics based on environmental problems.

Results

The research results showed that teaching physics based on environmental problems significantly increases the effectiveness of the educational process. During the experimental work, changes in the cognitive activity of students, interest in science, the ability to apply knowledge in practice, and the level of environmental awareness were comprehensively analyzed.

Student cognitive activity and participation in the lesson

In physics lessons organized on the basis of environmental problems, it was observed that the cognitive activity of students is higher than in traditional lessons. Students in the experimental group were actively involved in asking questions, participating in discussions, and drawing independent conclusions during the lesson. It was found that students' interest increased even more when real-life situations related to environmental problems were discussed.

According to the results of pedagogical observation, in lessons of ecological content, students strived to freely express their thoughts, proposed various solutions to problem situations, and tried to substantiate them based on physical laws. This situation showed that their cognitive activity and independent thinking skills were developed.

Level of interest and motivation in physics

As a result of the experimental work, it was established that in the group trained on the basis of environmental problems, interest in physics increased significantly. Students began to perceive physics not only as a set of theoretical knowledge, but also as an important subject that serves to explain and solve environmental problems.

The results of the survey and interviews showed that the students of the experimental group highly appreciated the vitality and practical significance of physics lessons. They considered lessons organized on the basis of environmental problems interesting, understandable, and useful. In the control group, such positive changes were observed less than in physics.

Ability to apply theoretical knowledge in practical situations

The research results showed that teaching based on environmental problems significantly developed students' ability to apply theoretical knowledge in practical situations. Students in the experimental group were able to explain such concepts as force, work, power, energy, heat exchange, electricity in connection with environmental problems.

For example, in the topic of energy saving, students were able to explain ways to reduce heat loss based on physical laws [6]. In the tasks related to alternative energy sources, they scientifically analyzed the advantages of obtaining electricity using environmentally friendly methods. This circumstance testifies to the conscious and firm assimilation of knowledge.

Formation of environmental awareness and responsibility

Physics lessons, organized on the basis of environmental problems, had a positive impact on the formation of ecological consciousness and a sense of responsibility in students. Students in the experimental group were able to explain the causes of environmental problems and their consequences in connection with physical laws.

According to the survey results, the majority of students indicated that they understand the need for rational use of energy and natural resources. Students also noted that they began to

feel a sense of personal responsibility in solving environmental problems. In the control group, such changes in the level of environmental awareness were less pronounced.

Level of understanding of interdisciplinary connections

In the course of the study, it was established that the teaching of physics based on environmental problems strengthens interdisciplinary integration. Students began to understand the inextricable link between physics and biology, geography, chemistry, and technology.

For example, when studying global warming, students identified the relationship between the greenhouse effect (physics), climate change (geography), and the composition of the atmosphere (chemistry). This expanded their scientific worldview and allowed them to perceive knowledge as a holistic system.

Results of project activities

Project activities, organized on the basis of environmental problems, developed students' research skills. In projects such as "Energy-Saving House," "Use of Solar Energy," "Water Resource Saving," students completed the stages of problem identification, goal setting, planning, conducting experiments, and analyzing the results.

The results of the project work showed that the students acquired skills in working in a team, defending their opinion, and presenting the results. This process contributed to the development of their communicative and social competencies.

Stability of knowledge and level of assimilation

The results of control works and tests showed that the stability of knowledge and the level of assimilation in the experimental group were high. It was established that students trained on the basis of environmental problems correctly remember the basic physical concepts and can apply them in practical situations even after time has passed.

These results show that teaching physics based on environmental problems has not only short-term, but also long-term educational effectiveness.

Discussion

The results of this study showed that the teaching of physics based on environmental problems has wide didactic possibilities in the educational process. The obtained results confirm that lessons of ecological content significantly increase students' cognitive activity and interest in science by connecting the theoretical and abstract concepts of physics with real-life problems. This situation aligns with the competency-based and personality-oriented approaches to education put forward in modern pedagogical concepts [7].

The positive changes in the activity and motivation of students observed during the study show that the choice of environmental problems as educational material directly led to the enrichment of the content of the educational process [8]. Since environmental problems are familiar and vital to students, they have transformed from a passive learner into an active participant in the learning process. This created the basis for the independent construction of knowledge by the student in accordance with the theory of constructivist education.

The development of the ability to apply theoretical knowledge in practical situations can be assessed as one of the important didactic advantages of teaching based on environmental problems. Connecting physical laws with environmental problems allowed students to understand the vital value of knowledge [9]. This situation, as emphasized in many scientific studies, serves to ensure the strength and long-term preservation of knowledge by connecting sciences with practice.

The formation of environmental awareness and responsibility is also one of the important results of this approach. The research results show that physics lessons, organized on the basis of environmental problems, serve to form a conscious attitude of students towards nature. In this process, physics becomes an effective tool for ecological education, and ecological education is further strengthened through interdisciplinary integration [10].

The strengthening of interdisciplinary integration has manifested itself as another important didactic possibility of teaching based on environmental problems. The close connection of physics with biology, geography, chemistry, and technology helped students understand that knowledge is a unified system. This situation expanded the students' scientific worldview and developed the skills of analyzing complex environmental problems based on a comprehensive approach.

The combination of project-based and problem-based learning methods with environmental content has shown its high effectiveness during the study. Through projects aimed at solving environmental problems, students not only deepened their knowledge of physics, but also developed research, communicative, and social competencies. These results are of particular importance from the point of view of the formation of "soft skills," which are important in modern education.

The research results showed that lessons organized on the basis of environmental problems have high educational effectiveness compared to traditional teaching methods. In traditional lessons, students are more in the role of recipients of ready-made knowledge, while in the ecological approach, they manifest themselves as active searchers and researchers. This once again confirms the effectiveness of the student-centered approach in the educational process.

At the same time, some limitations were identified during the study. Teaching physics based on environmental problems requires high methodological training, interdisciplinary knowledge, and additional time resources from the teacher. However, these limitations can be eliminated by improving teachers' qualifications and developing methodological manuals. This situation indicates the need for systematic and phased work in implementing an ecological approach into educational practice [11].

In general, the research results confirm that teaching physics based on environmental problems can be one of the priority areas of modern education. This approach not only increases students' interest in science, but also serves to shape them as environmentally responsible individuals with scientific thinking and an understanding of sustainable development ideas [12].

Conclusion

This study showed that the teaching of physics based on environmental problems has effective didactic possibilities in the modern educational process. Physics lessons, enriched with ecological content, increase students' cognitive activity and interest in science, and ensure conscious and solid assimilation of knowledge.

The research results confirmed that teaching based on environmental problems develops students' ability to apply theoretical knowledge in practical situations. Connecting physical laws with issues of energy conservation, alternative energy sources, and the protection of water and air resources reveals the practical significance of physics.

The educational process, organized on the basis of environmental problems, forms in students a sense of ecological consciousness and responsibility. At the same time, interdisciplinary integration ensures the close connection of physics with biology, geography, chemistry, and technology, expanding the scientific worldview of students.

The harmonious application of project-based and problem-based learning methods with environmental content contributes to the development of students' independent, critical, and creative thinking skills. Such an approach fully corresponds to the requirements of competency-based education.

In conclusion, teaching physics based on environmental problems, along with improving the quality of education, serves the formation of a young generation with ecologically responsible and scientific thinking. Therefore, it is important to systematically implement this approach in physics lessons and improve the methodological training of teachers.

References

[1] Kimori, D. A., & Roehrig, G. (2021). Environmental Topics in Physics by Inquiry Course: Integration Models Used by Physics Teachers. *The Qualitative Report*, *26*(5), 1601-1617. https://doi.org/10.46743/2160-3715/2021.4401
[2] А.Е.Отарбаев, Модель формирования у школьников интереса к изучению физики в контексте глобальных проблем и экологии //СПО 2(354)2025, стр.37-41
[3] Lousley, Cheryl. (1999). (De)Politicizing the Environment Club: environmental discourses and the culture of schooling. *Environmental Education Research*, 5 (3), 293-304. https://doi.org/10.1080/1350462990050304
[4] Malandrakis, G., Boyes E. and Stanisstreet M. (2011). Global warming: Greek students' belief in the usefulness of pro-environmental actions and their intention to take action. *International Journal of Environmental Studies*, 68 (6), 947-963. https://doi.org/10.1080/00207233.2011.590720
[5] Sukma, E., Ramadhan, S., & Indriyani, V. (2020). Integration of environmental education in elementary schools. Journal of Physics: Conference Series, 1481(1), 012136. https://doi.org/10.1088/1742-6596/1481/1/012136
[6] Rauch, F., & Steiner, R. (2013). Competences for Education for Sustainable Development in Teacher Education. *Center for Educational Policy Studies Journal*, 3(1), 9-24. https://doi.org/10.26529/cepsj.248
[7] El Azzouzi, A., Elachqar, A., & Kaddari, F. (2023). Exploring the evolution of student interest: Investigation of the scientific aspects of learning physics towards renewable energy. *E3S Web of Conferences*, 412, 01001. https://doi.org/10.1051/e3sconf/202341201001
[8] Bicalho, L., & Oliveira, M. de. (2011). The theory and practice of interdisciplinarity in Information Science. *Perspectivas em Ciência da Informação*, 16(3), 47-74. https://doi.org/10.1590/S1413-99362011000300004
[9] A. E. Otarbaev "The role of physics in the formation of ecological education of schoolchildren" // International Journal of Pedagogics. 2025. Vol. 05. pp. 102-106 https://doi.org/10.37547/ijp/Volume05Issue01-28
[10] Matthew N. O. Sadiku, Tolulope J. Ashaolu, Abayomi Ajayi-Majebi, and Sarhan M. Musa. (2021). Environmental Physics: An Introduction. *International Journal Of Scientific Advances.* (2)1, 32-34. http://dx.doi.org/10.51542/ijscia.v2i1.7
[11] S.A. Tursınbaev, A.E. Otarbaev, O.N. Yusupov, S.M. Kasımov. Spektr chiziqlarini o'lchash uchun difraktsion spektrometrni yig'ish // Fan, Jamiyat va Innovatsiyalar. Vol. 3 Issue 21. 2025, №. 4, b. 20-26. https://uzresearch1.uz/index.php/FJI/article/view/480/518
[12] A.Otarbaev, A.Janabaev, I.Satimov "The role of physics in the formation of students' ecological consciousness" // Germany-scientific review of the problems and prospects of modern science and education/ 2025. Vol. 1. pp. 24-27. **https://doi.org/10.5281/zenodo.15156710**