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Integration of Physics in Ecological Education: Theory and Practice

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Abstract: This study is aimed at studying the integration of physics into environmental education and assessing the effectiveness of explaining environmental issues to students through a scientific approach. The study analyzes how the connection of environmental education with the science of physics contributes to the development of environmental consciousness and a scientific understanding of environmental problems. In the process of studying, through interactive lessons, practical classes, and project work, students were given knowledge about explaining environmental problems based on physics, energy resource management, and the environmental benefits of renewable energy sources. The research results showed that the integration of physics into environmental education will be effective in increasing students' environmental awareness, developing a scientific approach, and understanding environmental issues.

Keywords: Environmental education, integration of physics, environmental awareness, interactive lessons, scientific analysis, managed resources, problems and limitations.

Introduction: Today, global problems faced by humanity, such as climate change, environmental pollution, energy crisis, and resource depletion, are becoming pressing issues not only in the field of ecology but in all scientific fields [1]. To effectively address these issues, comprehensive knowledge and multidisciplinary approaches are necessary. The application of new methods and modern pedagogical approaches in environmental education plays an important role in preparing society for environmental protection [2], awareness of environmental responsibility, and sustainable development.

Understanding important concepts such as environmental education, natural resource and environmental management, energy efficiency, and the use of renewable energy sources requires the integration of not only ecology but also other disciplines, such as physics [3]. Physics, through its fundamental laws, is one of the main tools for understanding the environment and analyzing ecological processes from a scientific point of view. For example, concepts such as energy conservation, heat exchange, and the physical properties of materials are effectively applied when approaching environmental issues.

In addition, the integration of environmental education with physics provides students with a clearer understanding of changes in nature and a scientific approach to it. Thus, the use of physics in solving environmental problems not only facilitates the scientific analysis of the environment [4], but also serves the development of ecological consciousness. It is at this point that the science of physics, connected with ecology, provides students not only with scientific knowledge, but also with practical skills.

Problems such as changing climate, depletion of natural

resources, and environmental pollution require the formation of ecological awareness worldwide [5]. Environmental education aims not only to increase responsibility for the natural environment but also to prepare society for new approaches from a scientific point of view through sustainable development [6]. At the same time, it is necessary to change the system of environmental education and introduce modern pedagogical methods. This, in particular, ensures the mutual integration of various scientific fields in solving environmental problems.

Physics is closely related to ecology, as there is a need for physical knowledge to understand ecological processes and approach them scientifically [7]. For example, understanding the operating principles of renewable energy sources, the laws of conservation of energy, and basic physical concepts such as heat and energy exchange are important for solving environmental problems. Integration of environmental education with physics plays an important role not only in the management of natural resources, but also in increasing energy efficiency and combating climate change [8].

Physics provides numerous tools for understanding the basic concepts of ecology and a practical approach to them [9]. For example, physical laws such as solar energy, wind energy, heat exchange, and energy conservation are directly related to ecological systems and processes. Thus, physics has scientific foundations used in the analysis of ecological processes and the solution of practical problems.

By integrating physics into environmental education, students learn to apply modern scientific approaches to the study of the environment [10]. For example, in environmental education, students learn to contribute to environmental sustainability by understanding renewable energy sources and their physical foundations. At the same time, issues such as the efficient use of energy, resource conservation, and reduction of environmental footprints are also studied using the basic concepts of physics.

The purpose of this research is to study the process of integrating physics into environmental education. The study provides for the fulfillment of the following tasks:

1. Studying the pedagogical significance of the integration of environmental issues and physics.

2. Demonstrate how physics is applied to environmental education, including explaining environmental processes through physical concepts such as renewable energy sources, the law of conservation of energy, and heat exchange.

3. Determining the role of physics in the development of students' ecological consciousness and developing effective methods of teaching ecological education through practical experience.

4. Further deepening of environmental knowledge by ensuring the connection between physical concepts and practices related to environmental issues.

Today, issues such as environmental protection, climate change mitigation, and the use of renewable energy sources are of global importance [11]. Therefore, the need to update environmental education and enrich it with scientific approaches is increasing. The integration of physics into environmental education provides scientific and practical approaches not only to understanding environmental problems, but also to solving them. Such integration not only increases the ecological awareness of students, but also encourages them to take a responsible approach to the environment and act on the path of sustainable development.

METHODOLOGY

This article explores the process of integrating physics into environmental education. The research methods were carried out in two main areas:

Literature analysis (theoretical basis)

Selection of literature: First of all, a wide range of scientific works and articles was collected for the purpose of analyzing existing scientific literature, research, educational materials, and pedagogical methodologies on the integration of ecological and physical sciences. Based on this literature, theoretical concepts were formed about the interrelationship between physics and ecology, how physics can be used in teaching environmental problems. The literature used in the study includes scientific articles written on topics such as environmental education, sustainable development, renewable energy sources, energy conservation, climate change, and environmental monitoring.

Analysis of the literature: At this stage, the possibilities

of using physics related to improving environmental education, increasing energy efficiency, and sustainable development were analyzed. Methodological recommendations, new methodologies, and pedagogical approaches related to the integration of environmental sciences and physics in the curricula were considered.

Theoretical analysis: With the help of literature analysis, theoretical ideas were formed about the importance of physics in explaining environmental problems, including such basic concepts as the law of conservation of energy, heat and energy exchange, renewable energy sources, and related environmental issues.

Applied research (Empirical research)

o Lessons and tests: Practical research was conducted to study the process of integrating environmental education into physics in educational institutions. The lessons were designed to combine ecology and physics. In the curriculum, lessons were conducted based on the following ecological and physical concepts:

- Solar energy and its physical foundations: Teaching solar energy as a renewable energy source and explaining this type of energy from a physical perspective [12].
- Law of Conservation of Energy and Ecology: Connecting Energy Conservation, Energy Efficiency, and the Physical Concepts of Energy with Environmental Issues [13].
- Wind energy and physics: Studying wind energy, providing students with information about its physics and environmental benefits [14].
- Heat and energy exchange: Teaching ecological processes related to the physics of heat and energy exchange and their impact on the environment [15].

o Surveys and interviews: At the end of the classes, students were surveyed and interviewed. This method was used to assess how students approached environmental issues, how the integration of physics and ecology impacted them, and the changes in the lesson process. As a result of the survey, it was found that students' environmental awareness has increased, and they have a better understanding of how to apply physics to solve environmental problems.

o Practical experience and projects: During the classes, students conducted physical research to solve environmental problems. For example, small practical projects were carried out, such as the construction of solar panels or wind turbines, in which students learned how to apply physical concepts for environmental purposes.

o Teacher Training: Special trainings were conducted to prepare teachers for the application of new pedagogical methods. During these trainings, teachers were provided with methodological recommendations and new methods necessary for teaching physics and ecology together. The trainings were aimed at creating effective approaches to working with students.

o Analysis and evaluation: Qualitative and quantitative methods were used to evaluate the research results. Assessment was carried out on the basis of various methods for measuring the ecological awareness of students, including tests, surveys, and observation of classroom activities. At the end of the lessons and projects, reassessments were conducted to determine the knowledge and skills acquired by the students.

o Assessment of experience and success: To assess the effectiveness of the integration of physics and ecology, the results obtained between the experimental groups were compared. In this section, the importance of physics in the development of students' ecological awareness and how their abilities in understanding environmental issues have changed were analyzed.

RESULTS

In this study, several important results were obtained based on experiments, tests, and practical activities carried out to study the process of integrating environmental education into physics. The main goal of the research is to assess the integration of physics into environmental education, to determine how environmental problems are related to the laws of physics, and to demonstrate their effectiveness in the development of students' environmental awareness. In this section, the main results of the research are presented in the following areas:

Effectiveness of the integration of physics in environmental education

In the lessons conducted during the study, it was

established that the integration of physics into environmental education is effective in the formation of students' understanding of environmental issues and a scientific approach to them. During the lessons, explaining environmental problems through the laws of physics, such as such concepts as solar energy, wind energy, energy conservation, expanded the scientific worldview of students and made it possible to see environmental problems on a scientific basis.

For example, teaching solar energy: During lessons on solar energy, students studied the physical foundations of energy sources, solar panels, and photosynthesis processes. As a result, students more clearly understood the environmental benefits of renewable energy sources and their impact on the environment.

Wind energy and physics: Lessons on the physical basis of wind energy have proven their importance in effective teaching of environmental education. Having familiarized themselves with the wind turbine and its operating principles, students gained a deeper understanding of the environmental benefits of this energy source and its production processes.

Increasing students' environmental awareness

During the study, an increase in environmental awareness among students was observed. Through lessons, practical exercises, and projects, students learned what approaches they can apply to solving environmental problems. There were clear differences in the development of environmental awareness among the experimental groups.

- Surveys and interviews: As a result of surveys and interviews conducted at the end of classes, students noted that they have taken a more responsible approach to environmental issues, and their knowledge of sustainable development and renewable energy sources has significantly increased. Students began to understand environmental problems not only from a theoretical but also from a practical point of view.
- The Law of Conservation of Energy: The study of the law of conservation of energy in classes demonstrated a scientifically based approach to solving environmental problems for students. The connection of the law of conservation of energy to environmental problems helped students understand the effectiveness of renewable energy sources.

Impact of interactive approaches in lessons

During the lessons, students were presented with practical experience and interactive approaches to solving environmental problems. For example, students learned to solve environmental problems through small projects, such as the construction of solar panels, the development of wind turbines. These approaches made it possible for students to take an even more active part in mastering environmental education.

- Projects and practical exercises: Students practiced the physical foundations of energy through environmental projects (such as solar power generation systems or wind energy studies). These practices helped to find new, scientifically based solutions in solving environmental problems.
- Interactive teaching: Through interactive teaching methods, including discussions, group developments, problems, and projects, students developed their scientific approaches. This approach played an important role in increasing the effectiveness of environmental education.

The impact of the integration of physics into environmental education on students

During the study, it was found that the integration of physics and ecology is effective for students. The role of physics in explaining environmental problems and its influence on the formation of ecological consciousness yielded positive results.

Issues of sustainable development: Based on physics, students have the opportunity to study sustainable development and renewable energy sources. The lessons covered physical concepts related to reducing environmental footprints and increasing energy efficiency.

Energy efficiency: Students understood the efficient use of energy and applied this knowledge to approach the environment responsibly. As a result, students were able to learn to reduce their environmental impact, save energy and resources.

RESULTS OF THE SURVEY AND ASSESSMENT

The data obtained from the survey and assessments of the study showed that the integration of environmental education into physics has led to positive changes in students. As a result of the surveys, improvements were observed in students' understanding of environmental problems from a scientific point of view and their

approach to them.

Assessment results: According to the assessment results, students demonstrated a significant improvement in their understanding of environmental issues, especially energy conservation and renewable energy sources. As a result of the increase in students' scientific approach and ecological awareness, they have strengthened their responsibility for the environment in their daily lives.

DISCUSSION

The research results showed that the integration of environmental education into physics is effective not only in the development of environmental consciousness, but also in the scientific and practical understanding of environmental issues. Through lessons, interactive sessions, and practical projects, it has been confirmed that students can become more effective in understanding and solving environmental problems on a physical basis. In this section, we will analyze the research results, discuss the problems associated with them, and future opportunities.

Effectiveness of the integration of physical and environmental education

The research results showed that the integration of physics into environmental education facilitates students' scientific approach to environmental issues and provides a deeper understanding of environmental problems. Physical concepts such as energy conservation, renewable energy sources, and heat exchange allowed students to acquire the scientific foundations necessary for solving environmental problems.

For example, renewable energy sources such as solar energy and wind energy were explained to students even more easily through physics [16]. As a result, students gained more knowledge about increasing energy efficiency and the environmental benefits of renewable energy sources. However, for some students, these processes are still complex and have shown that they need more practical examples and guidelines. Therefore, in order to widely disseminate this approach, it is necessary to further improve practical exercises and laboratory work.

Increasing students' environmental awareness

In the course of the study, it was established that the integration of environmental education into physics is effective in increasing the environmental awareness of students. Data obtained through surveys and interviews showed that students took a more responsible approach to understanding environmental problems. As a result of the assessments conducted during the lessons, the students noticed changes in environmental issues. Their understanding of environmental issues, energy resource management, and renewable energy sources has been further strengthened.

However, scientific knowledge alone is not enough in the formation of ecological consciousness [17]. Students need to learn how to apply environmental problems in everyday life. For example, students need to develop practical skills to fully understand the practical aspects of using solar energy. The study also requires more interactive and practical exercises for the formation of environmental awareness.

Pedagogical approaches and practices

The importance of pedagogical approaches in the integration of physics into environmental education deserves special attention [18]. During the study, interactive lessons and practical classes on environmental problems and the basics of physics were effective. These approaches activate students, encourage them to study environmental issues, and pay more attention to scientific analysis.

For example, when projects were conducted among students on the creation of solar panels and the operation of wind turbines [19], they not only studied the physical foundations of environmental problems, but also understood their practical aspects. At the same time, through such projects, students became more involved in the application of environmental education. However, for some students, the practical exercises were challenging, requiring more time and guidance. In the future, it will be necessary to organize even more such classes.

Problems anddeficiencies

Some problems also arose during the research. Basically, when integrating environmental education with physics, the differences between the existing level of knowledge of many students and their needs in relation to pedagogical approaches were revealed. For example, some students experienced difficulties in understanding physical processes and environmental

problems. Therefore, it is important to ensure individual approaches among students in the process of such integration.

In addition, the lack of resources in integrating environmental education into physics can also lead to problems. In some lessons, there were insufficient resources for the necessary educational materials, laboratory equipment, or practical experiments to teach environmental problems. To address this issue, educational institutions need to invest more of their resources in improving the ecosystem and implementing modern pedagogical tools.

Future opportunities and proposals

The research results showed that the positive impact of integrating environmental education into physics can be further expanded. Teaching students ecological problems on a scientific basis is important for the development of their ecological consciousness [20]. Therefore, in the future, this approach can be applied on a broader scale in other disciplines. For example, integration with biology, chemistry, and geography contributes to the further deepening of environmental education.

It is also possible to work more with students through interactive methods [21], project-based learning, practical exercises, and research projects. It is necessary to develop new educational materials and technologies to improve resources and develop students' scientific and practical skills.

CONCLUSION

This study showed the effectiveness of integrating environmental education into physics in the development of students' environmental awareness, strengthening a scientific approach, and understanding environmental issues. The connection of physics with environmental problems helped students to look at environmental problems from a scientific point of view and solve them. In the future, there are opportunities for integrating this approach with other disciplines and organizing more effective environmental education through practical exercises.

The research results showed that the integration of environmental education into physics plays a very important role in the development of students' scientific and practical skills. At the same time, this approach will need to be expanded and improved in the future. The research results showed the necessity of using new pedagogical approaches, technologies, and resources in the implementation of environmental education. This allows for the effective development of environmental education.

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. Pruneau, D., Doyon, A., Langis, J., Vasseur, L., Quellet, E., McLaughlin, Boudreau, G., and Martin, G. (2006). When Teachers Adopt Environmental Behaviors in the Aim of Protecting the Climate. The Journal of Environmental Education, 37 (3), 3-12. https://doi.org/10.3200/JOEE.37.3.3-12
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. Egbert Boeker, Rienk van Grondelle and Piet Blankert. Environmental physics as a teaching concept. July 2003. European Journal of Physics, 24(5): S59. http://dx.doi.org/10.1088/0143-0807/24/5/301
12. David Kimor. (2019). Integration of Environmental Issues in a Physics Course: 'Physics by Inquiry' High School Teachers' Integration Models and Challenges. Journal of Education and Training. Vol.6, No.1., http://dx.doi.org/10.5296/jet.v6i1.13441
13. Briscoe, C., & Wells, E. (2002). Reforming primary science assessment practices: A case study of one teacher's professional development through action research. Science Education, 86(3), 417-435. https://onlinelibrary.wiley.com/doi/abs/10.1002/sce.10021.
14. Darling-Hammond, L. (2008). Teacher learning that supports student learning. Teaching for intelligence, 2, 91-100. https://eric.ed.gov/?id=EJ560879.
15. Stiggins, R., & Chappuis, J. (2005). Using student-involved classroom assessment to close achievement gaps. Theory Into Practice, 44, 11-18. http://doi.org/dckdhb.
16. S. G. Yalmanci and A. I. C. Gözüm, “The study of whether receiving a pre-school education is a predictive factor in the attitudes of high school students toward the environment according to their environmental ethics approach,” Int. Electron. J. Environ. Educ., (9)1, 18–32. 2019. https://www.researchgate.net/publication/332253877
17. M. Negev, Y. Garb, R. Biller, G. Sagy, and A. Tal, (2010) “Environmental problems, causes, and solutions: An open question,” The Journal of Environmental Education, 41(2), 101–115. http://dx.doi.org/10.1080/00958960903295258
18. Otarbaev A., Alieva G., & Tajimova R. (2025). Research of meteorities using modern technologies. // Универсальная индексная библиотека инновационных исследований в современном мире: теория и практика, 4(14), 136–139. извлечено от http://lib.uniconflix.com/index.php/uilzdit/article/view/51458
19. A.E.Otarbaev, Turganbaeva G.A, & Baltabekova A.E. (2026). Use of digital technologies in physics education. // Universal journal of social sciences, philosophy and culture, 3(24), 105-113. https://sr-journals.org/index.php/UJSSPC/article/view/673
20. A. G. Cole, “Expanding the field: revisiting environmental education principles through multidisciplinary frameworks,” J. Environ. Educ., vol. 38, no. 2, pp. 35–46, 2010. https://doi.org/10.3200/JOEE.38.1.35-46
21. J. Palmer, Environmental education in the 21st century: Theory, practice, progress and promise. New York: Routledge, 1998. https://doi.org/10.4324/9780203012659