Using Ecological Concepts In Interdisciplinary Physics Education

Karimov Abdurakhmonjon Marufjon ugli
Independent researcher, Department of Physics, Namangan State University
Zakhidov Ibrokhimjon Obidjonovich
Associate Professor, Department of Physics, Namangan State University, Ph.D. in Pedagogical Sciences

Abstract. This article highlights the pressing need to fundamentally change our perspectives on the environment, to find solutions to ecological problems, to anticipate potential consequences, and to maintain stability while ensuring the harmony of nature and humanity. In order to gain a comprehensive understanding of nature and its laws, it is essential to foster students' ecological thinking, worldview, and culture. By integrating ecological concepts into physics curricula through interdisciplinary connections, students can see how physics topics intersect with environmental knowledge. Moreover, the 6th-grade "Natural Sciences" curriculum in secondary schools—particularly its sections on "Structure of Matter" and "Ecology and Sustainable Development"—can help lay the groundwork for deepening students' understanding of biology, geography, physics, chemistry, and astronomy. This paper provides relevant ecological concepts that bolster interdisciplinary links and offers recommendations for their application.

Keywords: nature, technological development, physics, interdisciplinary integration, ecological problems, use of ecological concepts, rational attitude to the environment.

Introduction. Natural laws remain unchanged as they were in the past and will continue so in the future. To acquire a holistic view of nature, one must thoroughly understand nature and its laws. Knowledge of natural laws provides precise information about the causes of various hazardous phenomena in nature and underscores the interconnectedness of natural laws and societal laws. Recognizing these relationships helps us foresee the future of both nature and humankind. Scientific knowledge of nature's laws also enables us to preserve it in a pristine state for future generations.

In an era when human activities—driven by scientific and technological development—significantly affect the environment, it is of great scientific and practical importance to predict future scenarios based on these natural laws. To avoid bringing irreparable harm to humanity through our impact on the environment, we need to anticipate the consequences of human activity. This requires extensive knowledge of nature and its laws, as well as the ability to apply that knowledge in practice. In this regard, it is essential to acquire precise knowledge of the natural and social laws studied by physics, astronomy, and technology. Teaching these subjects, beginning with basic physics in schools, can yield positive outcomes. In solving the relevant issues, it is advisable to rely on interdisciplinary approaches.

Ensuring the healthy upbringing of the younger generation has become a central aspect of state policy. A "healthy generation" implies not only physically strong young people but also those who possess deep knowledge, a high level of moral integrity, and the capacity to compete on a global scale while safeguarding the nation's wealth. Globally, along with education, significant attention is given to raising environmental awareness and encouraging environmental protection. Accordingly, the necessity to develop students' ecological thinking has grown, particularly by teaching physics in conjunction with other subjects.

Literature review. In their research at Michigan State University, In-Young Cho and Charles V. Anderson advise using model-based explanations for changes in matter in both human and natural environments. They suggest linking microscopic and macroscopic changes of matter by taking into account the flow of substances within systems and viewing macroscopic processes from an atom-molecular perspective. Their findings indicate that many students struggle with making these links consistently when explaining gas, solid, or liquid interactions and with applying ecological literacy to such problems [1].

In his academic research, E. O. Turdiqulov discusses the content of ecological education in teaching natural sciences, explores the forms and methods of studying these subjects, and examines ways to convey their ecological content based on interdisciplinary connections [2].

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N. M. Khodjibolayeva focuses on the concept of ecological competence, revealing its social and pedagogical aspects, its components, and how it manifests in individual activities, emphasizing its importance in addressing critical environmental issues today [3].

B. Kh. Norbotayev shows how to provide students with ecological education by linking biology courses with chemistry and physics. He emphasizes the formation of students' theoretical ecological knowledge, practical skills, and ecological thinking, along with the use of modern teaching technologies to synchronize or asynchronize natural science subjects [4]. Many other works can be cited in this regard.

In secondary education, notably at the 6th-grade level, the subject "Natural Sciences" [5] incorporates knowledge that fosters interdisciplinary connections and prepares students for more in-depth study of biology, geography, physics, chemistry, and astronomy in higher grades. A separate chapter, "Ecology and Sustainable Development," is included, covering climate and its changes, as well as interactions within ecosystems. This underscores the importance of integrating ecological education and upbringing from an early age.

Research methods. Disruption of ecological balance manifests itself in soil, air, groundwater, sea, and ocean pollution, as well as in solid waste, toxic substances in food, noise pollution, the hazardous effects of radioactive materials, and other concerns. Rather than learning and carefully applying natural laws, humankind has rapidly damaged and contaminated its living environment.

Unaddressed ecological crises can lead to catastrophic outcomes in certain regions of the planet. Ecological problems inevitably increase environmental risks if not resolved in time. Ecological stress refers to the state of reciprocal relations between nature and human beings, emerging from imbalances between society's productive forces and production relationships, thus altering the material-ecological capacities of the biosphere. Ecological catastrophe denotes an extreme situation in which human intervention in natural processes leads to severe negative economic consequences or even mass casualties in a specific region.

The term ecological problem is used to describe issues arising from humanity's impact on nature and nature's reciprocal impact on humans. For instance, air pollution is one of today's most pressing global challenges. Rapid industrial development and the expansion of motor vehicles are the primary causes of atmospheric pollution, including large emissions of carbon and sulfur compounds, oxide acids, hydrocarbons, sulfur dioxide, and other substances, all of which harm the environment and human health. Major urban areas are especially affected by these pollutants, making air pollution a concern for all of humanity.

Air is vital to human survival. A person can survive for around five weeks without food, five days without water, but only five minutes without air. This demonstrates the need to radically revise our approach to the environment, seek solutions for ecological issues, and maintain ecological and human harmony for future generations. This, in turn, demands enhanced ecological education and the consistent fostering of students' ecological thinking. Since the science of physics examines nature and natural phenomena, it should be taught with these broader implications in mind.

Currently, students struggle to apply their theoretical knowledge of physics to environmental events and processes. At the same time, many fail to fully recognize the significance of physics in understanding natural laws. This deficiency hinders the expected development of students' physics skills. Encouraging secondary school students to investigate local environmental conditions, analyze ecological challenges from a physics perspective, and participate in practical measurements can address these shortcomings. By observing numerous occurrences—for example, the role of soil moisture and salinity, the influence of solar energy on vegetation, extreme climate fluctuations, variations in rainfall, drought severity, and the impact of harmful mineral concentrations on plants—students learn to interpret these issues as physical phenomena. As a result, they better understand the essence of these processes. Moreover, cultivating a responsible attitude toward local ecosystems and engaging in relevant practices help students integrate their knowledge from physics, chemistry, biology, and practical training.

Analyses of students' knowledge levels indicate that interdisciplinary connections play a crucial role in understanding the physical nature of ecological phenomena [6].

Results. Because natural sciences-particularly physics and biology—are closely linked in their subject matter and research objects, implementing interdisciplinary connections in teaching clarifies the content and meaning of phenomena in nature. By forming holistic perceptions based on knowledge gained in various subjects and developing corresponding practical skills, students' ecological thinking can be broadened. Table

1 illustrates examples of how themes related to physics in the 6th-grade "Natural Sciences" textbook can be connected with ecological concepts.

Table 1

Integrating physics topics from the 6th-grade "Natural Sciences" textbook with ecological concepts

No.	Physics Topic	Ecological Connections (via Interdisciplinary Links)
1	Structure of Matter	Chemical composition of the atmosphere and the physical effects of pollution (heat conduction, air currents)
2	Observing the Three States of Matter	Effect of climate change on the water cycle (melting glaciers, evaporation)
3	Gases	Air pollution, greenhouse gases and global warming, changes in atmospheric composition
4	Liquids	Water resources and pollution, rising sea levels, hydrodynamic phenomena
5	Studying Diffusion	Dispersion of gases in the atmosphere, air pollution and its impact on the environment
6	Solids	Movement of Earth's crust, soil erosion, processing of solid waste
7	Density of Substances	Density of wood and plastics-issues of using eco-friendly materials
8	Determining the Density of Objects of Various Shapes	Relationship between the density of solids/liquids and pollution levels in the environment
9	Boiling, Evaporation, and Condensation	Factors affecting evaporation, water scarcity and its mitigation, efficient use of water, formation of dew, fog, clouds, and hail, predicting cold snaps

Likewise, ecological topics can be reinforced using physics concepts to improve interdisciplinary effectiveness and lesson quality (see Table 2).

Table 2

Integrating ecology topics from the "Ecology and Sustainable Development" chapter of the 6th-grade "Natural Sciences" textbook with physics concepts.

No.	Ecology Topic	Related Physics Concepts (via Interdisciplinary Links)
1	Climate	Temperature, thermometers, variations in air temperature, heat quantity
2	Factors Affecting Climate	Solar radiation, Earth's warming, modes of heat transfer (convection, thermal radiation)
3	Impact of Climate Change on the Earth	Melting ice, evaporation and condensation, water cycle
4	Interactions in Ecosystems	Circulation of matter and energy, effects of heat on the environment
5	Energy Flow in Ecosystems	Solar energy, photosynthesis, conservation and transformation of energy
6	Obtaining Clean Drinking Water	Physical properties of water (density, clean vs. polluted water), purification (filtration, distillation)

For example, when teaching the lesson on "Temperature," incorporating the following ecological information can be highly effective. Obviously, heat is one of the key factors sustaining living organisms. Heat phenomena are tied to processes of warming or cooling in the environment. A sudden 20°C increase or

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decrease in air temperature would drastically transform the surrounding environment. Many natural processes depend on heat. Consequently, introducing temperature as the principal parameter used to characterize heat-related phenomena is crucial.

For life to exist on Earth, the temperature must remain within suitable limits. A relevant example is rising CO_2 levels in the air, which lead to increasing temperatures. Should the global temperature rise by 10°C, the Earth's climate would change drastically, adversely impacting global biomass. Mitigating such effects demands addressing factors that upset heat balance. In the summer, especially during windy conditions, extensive evaporation from soils and water bodies can cause crops to wither. If cotton plants, for instance, are not adequately irrigated before flowering, the moisture they contain evaporates, leading to the shedding of blossoms, diminished boll formation, and ultimately reduced yield. Similarly, hot weather significantly increases water consumption in humans, which can affect cardiac function.

A vital question posed to students is: How can evaporation be reduced?

1. Transporting water across long distances in enclosed concrete channels to prevent evaporation and infiltration
2. Planting trees along wind corridors to reduce wind speed over farmland and thus evaporation from soil and crops
3. Digging irrigation channels deeply so that a smaller water surface area is exposed
4. Irrigating fields at night to reduce evaporation and improve water absorption in plants
5. Employing artificial rainfall to water crops

Beyond water, other liquids—including some hazardous substances—or even solid materials can evaporate. When these substances evaporate, diffusion disperses them throughout the environment, polluting the air. Anyone breathing such contaminated air could be harmed. Preventing the evaporation of toxic substances, and avoiding their storage in residential areas, are critical.

When teaching "Evaporation," teachers might emphasize:

• Observing water evaporation experimentally
• Examining how a drop in temperature accompanies evaporation
• Showing how moderate evaporation fosters healthy plant growth, while excessive evaporation dries them out

This also covers how vegetables in storage may lose water through evaporation, degrading their quality if not kept at optimal temperatures. Students learn from textbooks that high ambient temperatures in summer can lead to the swift evaporation of water in irrigation channels, rivers, and natural or artificial ponds, leaving insufficient water for crops and livestock and potentially causing serious economic damage. By integrating ecological material into physics lessons-without deviating from each lesson's objectives-teachers can leverage interdisciplinary connections to develop students' thinking skills.

Discussion. Examining nature–society interactions increasingly reveals that isolating them during analysis is ineffective. These are ecological issues that are mutually linked and interdependent. Therefore, restoring and maintaining environmental balance requires collective effort, especially in educational settings.

When teaching physics through an interdisciplinary lens that includes ecological concepts, it becomes crucial to ensure social, economic, personal, and vocational relevance—encouraging students to apply ecological knowledge in daily life and solve environmental issues. This integration is urgently needed to equip learners with effective, real-world competencies.

Incorporating ecological knowledge into physics fosters deeper understanding, logical thinking, and robust skill-building in students. Enhancing interdisciplinary connections also supports continuous and coherent education. Specifically:

1. Physics Instruction Methodology: Provide methodological guidelines that encourage creative engagement with natural phenomena and incorporate ecological knowledge through interdisciplinary links, grounded in sound pedagogical and psychological insights.

2. Ecological Knowledge in Physics: Show how physics lessons—much like those in other subjects-offer opportunities to cultivate environmental consciousness and ecological literacy.

3. Pedagogical Process: Demonstrate how students can more effectively learn about fluids, gases, thermal processes, sound, and pressure by integrating ecological perspectives, illustrating how these topics mutually reinforce and lead to holistic learning outcomes [7–14].

Encouraging a prudent approach to the environment, ensuring that natural resources remain available for future generations, and preventing anthropogenic harm all rest heavily on ecological education. Given that initial elements of ecological knowledge are introduced in secondary schools, its importance in facilitating harmony between nature and society cannot be overstated. Incorporating it into curricula nurtures students' love and respect for nature as well as their sense of resource conservation.

In classroom and extracurricular activities, a systematic approach—using observations, experimental analyses, and interactive discussions-helps strengthen environmental awareness. Physics lessons outside the classroom can also guide students in identifying and mitigating the ecological problems they encounter daily.

Conclusion. Human interactions with the natural world and society's broader systems underscore the importance of education grounded in an understanding of the surrounding environment. In secondary schools, the effectiveness of ecology-focused instruction relies on interdisciplinary approaches across all subjects, including natural sciences such as physics. Students'ecological hinking, worldview, and environmental culture largely depend on how effectively physics teaching incorporates interdisciplinary links. Collaborative efforts among various disciplines not only advance scientific understanding but also foster the intellectual growth of students. By bridging environmental concepts with physics, educators can better prepare future generations to address and resolve global ecological challenges.

References

1. https://envlit.educ.msu.edu/publicsite/files/CarbonCycle/CC%20ResearchPaper/CC%20ChoPhyChem.pdf?utm
2. Турдикулов Э.А. Экологические оброзование в воспитание учащихся в прцессе обучения физики. –М.: Просвещение, 1988, 126 с.
3. Ходжиболаева Н. М. Экологик компетентликнинг ижтимоий-педагогик мазмуни ва унинг компонентлари. "Science and Innovation" халқаро илмий журнали ISSN:2181-3337 UIF=8.2, 2022 йил 6 -сони. 250-2563-бетлар.
4. Норбўтаев Х. Б. Биологияни табиий фанлараро синхрон - асинхрон ўқитишда ўқувчи экологик тафаккурини ривожлантириш шакл ва методларини такомиллаштириш. Ўқув қўлланма. Тошкент-2019, 157 б.
5. Sangirova Z. B. va boshq. Tabiiy fanlar: 6-sinf uchun darslik / - Toshkent: Respublika ta'lim markazi, 2022. –192 b.
6. https://cyberleninka.ru/article/n/fizika-itishda-ekologik-mazmunda-masalalardan-foydalanishning-ozirgi-olati
7. Ibroximjon Z., Tabiiy fanlarni o'qitishda A. K. Suv va suvga doir bilimlardan foydalanish orqali o'quvchilarning ekologik tafakkurini rivojlantirish //Fergana state university conference.-2023.
8. Boyturayeva G., Zakhidov I. Orienting 7th-Grade Students Towards Career Choices Through Interdisciplinary Teaching of Physics //Maktabgacha va maktab ta'limi jurnali. – 2025. – Т. 3. – №. 3.
9. Zakhidov I. O., Karimov A. M. Development of students'ecological culture by directing innovative activities using steam technology //Science and innovation. – 2024. – Т. 3. – №. A10. – С. 251-255.
10. Umarov A., Zakhidov I., Boyturayeva G. Interdisciplinary relationships and its application in teaching the topics of electricity in a school physics course //Science and innovation. – 2024. – Т. 3. – №. B1. – С. 166-170.
11. Zakhidov I., Boyturayeva G. Use of Natural Science and Geography materials in Physics teaching //Science and innovation. – 2023. – Т. 2. – №. B3. – С. 483-487.
12. Obidjonovich Z. I., A'Zamjon A. D. 6-sinf fizika fanida tovush hodisalarini o 'qitish orqali ta'lim samaradorligini oshirish yo 'llari //Oriental renaissance: Innovative, educational, natural and social sciences. – 2021. – Т. 1. – №. 3. – С. 424-432.
13. Alizhanov D. A., Zokhidov I. O. Teaching in Physics "Electrical Instruments in the House". Saving Electricity //Turkish Online Journal of Qualitative Inquiry (TOJQI). – 2021. – Т. 12. – №. 9. – С. 6107-6112.
14. Boyturayeva G. K., Zakhidov I. O. Ways of implementing interdisciplinary connections in teaching the topics of" electric charge" and" electric resistance" in the 7th grade //Science and innovation. – 2024. – Т. 3. – №. A10. – С. 246-250.