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SCIENTIFIC FOUNDATIONS AND HISTORICAL ROOTS OF ECOLOGICAL EDUCATION

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Annotation: This article explores the development of ecological education, its scientific foundations, and historical roots. It analyzes the emergence of ecological knowledge, the evolution of human attitudes toward nature, and the ecological ideas reflected in ancient philosophical teachings as well as in Eastern and Western scientific traditions. The paper also examines modern concepts of ecological education, international environmental programs, and methodological approaches to fostering ecological culture within the education system of Uzbekistan. Furthermore, it highlights the pedagogical significance of ecological upbringing and presents effective methods for cultivating environmental responsibility and sustainable development principles among learners.

Key words: ecological education, environmental upbringing, historical roots, scientific sources, ecological culture, sustainable development, environmental awareness, ecological safety, pedagogical approach, environmental competence, nature protection, modern education, ecological concepts, ecological methods, ecological processes.

Ecological education is not merely the provision of biological knowledge or warnings about protecting nature; rather, it is a multifaceted pedagogical process aimed at shaping a conscious, sustainable, and responsible attitude toward the environment. At the present stage, the essence of ecological education is defined by an individual’s ability to understand the balance between human activity and the surrounding environment, as well as their readiness to contribute actively to preserving this balance.

Ecology is a science that studies living organisms, their habitats, their interactions with the environment, and the patterns that arise from these interactions. The term ecology was first introduced into science in 1868 by the German biologist Ernst Haeckel. He derived the word “oekologie” from the Greek “oikos” meaning “house, dwelling” and “logos” meaning “study,” thus referring to the study of the relationships between organisms and their environment [4].

In any developed society, maintaining human health and increasing work capacity are considered priority areas of state policy. In this regard, intellectuals, educators, healthcare workers, and representatives of mass media play an important role in promoting and explaining hygiene rules [5].

The concept of hygiene originates from the Greek word “hugieinos,” and it studies the external environmental factors affecting human health. Based on this, it develops scientifically grounded principles aimed at improving environmental conditions to strengthen health, prevent infectious diseases, and extend life expectancy [6]. Therefore, ecology and hygiene are closely interconnected sciences that ensure the relationship between human health and the living

environment. Without a healthy environment, it is difficult to maintain physical well-being. The formation of a healthy lifestyle and its implementation in daily life depend on a person's conscious actions. In this regard, educational outreach and personal example serve as important tools.

Ecological and hygienic issues are among the most pressing challenges in the Republic of Uzbekistan, and addressing them requires active cooperation among all sectors of society [7]. In particular, the reform and development of the ecological and hygienic education system plays a significant role in this process. This work must begin within the family, preschool institutions, and schools.

Ecological and hygienic education represents an essential stage in shaping a new type of relationship between humans and the biosphere, fostering a conscious attitude toward the environment. Delivering such knowledge to children in accordance with their age, interests, and local traditions increases the effectiveness of the educational process [8]. Today, starting from the 5th grade in general education schools, it is of great importance to teach students ecological knowledge and to introduce these concepts into family settings as well. This requires teachers to be proactive and demands the active participation of every parent, community member, public servant, religious leader, and representative of mass media [9].

As a conscious part of nature, humans benefit from its generosity and gifts. Therefore, respect and care for nature must be cultivated from early childhood. Protecting and valuing nature is not only a duty but also a moral responsibility for every individual [10].

Water, air, and soil are essential sources of life for all living organisms, including humans. These factors directly affect human health. Eastern and Western scholars have long referred to water as "a source of tranquility" or "the queen of health," emphasizing its vital importance [11]. Water is one of the most significant ecological factors and plays a key role in ensuring a healthy lifestyle for the population.

Today, the intensification of environmental problems, climate change, and the limited nature of natural resources have made the development of ecological culture a pressing global necessity. The need to cultivate environmental awareness and responsibility among young people from an early age is growing every day. From this perspective, the general secondary education system-especially the primary education stage-serves as the foundational platform for shaping ecological upbringing.

Forming ecological values among primary school students, developing their conscious attitude toward nature, and strengthening their ability to apply ecological knowledge in practical activities are among the priority tasks facing today's education system. In particular, the content of natural science subjects taught in grades III-IV provides favorable opportunities for mastering ecological concepts. However, the insufficient depth of ecological approaches in existing textbooks and methodological materials, the limited use of interactive methods, and the inadequate proportion of practical activities indicate the need for new methodological approaches in this field.

Deepening ecological education through the implementation of modern pedagogical technologies, developing students' independent thinking, observation, and analytical skills, as well as fostering ecological competencies, has become one of the key tasks of contemporary pedagogy. Therefore, this research highlights the necessity of thoroughly studying the methodological features of ecological education in the context of natural science subjects taught in grades III-IV, improving these methods, and integrating them into educational practice.

In modern educational theory, ecological culture is interpreted as an integral part of human values.

Conceptual views put forward by UNESCO, UNEP, and other international organizations emphasize that ecological upbringing must begin at an early age. This necessitates the deep integration of ecological awareness formation into educational strategies at the primary school level. From a pedagogical perspective, ecological education should be organized in the following directions:

Ecological awareness - developing students' ability to understand natural phenomena and environmental problems;

Ecological culture - acquiring moral values based on an understanding of the interdependence between humans and nature;

Ecological activity - applying acquired knowledge in practice, for example, separating waste or participating in small projects aimed at environmental protection;

Ecological responsibility - understanding the consequences of one's actions and being prepared to contribute to environmental sustainability.

To develop such competencies, theoretical material alone is not sufficient; it must be reinforced through practical activities, observation, experimentation, and solving problem-based situations using interactive methods.

Primary school is not only a stage for imparting knowledge but also a crucial period for shaping the student's personality. Therefore, ecological education at this stage should be conducted not only through natural sciences but also integrated with subjects such as the native language, visual arts, technology, and even physical education. Natural science subjects in grades III-IV provide particularly favorable opportunities for such an integrated approach. In these grades:

- students begin to understand regional environmental problems;
- they develop observation and analytical skills through practical and experimental activities;
- they relate acquired knowledge to real-life activities.

The following methodological approaches play an important role:

1. Problem-based learning - fostering ecological thinking by prompting students to ask "why?" and "how?" questions;
2. Project-based approach - developing small group ecological projects, for example, creating green spaces within the school grounds;
3. Interactive methods - enhancing lesson engagement through techniques such as brainstorming, concept mapping, and ecological debates;
4. Multimedia resources - stimulating student interest through animations, virtual excursions, and videos on ecological topics.

These methods deepen students' ecological knowledge, shape ecological values, and most importantly, instill the principles of sustainable development in children's minds. In recent years, special attention has been paid within the education system of the Republic of Uzbekistan to fostering ecological culture and promoting sustainable development ideas. Evidence of this includes a series of normative-legal documents, decrees, and resolutions that have established practical mechanisms for the development of ecological education.

In particular, Resolution PQ-184, adopted on May 15, 2025, mandates further improvement of the ecological education system in general education institutions, the establishment of "ecological corners" in schools, the promotion of a "green consumption" culture, and the creation of animated educational products on ecological topics for children [1]. This document serves as an important legal basis for developing ecological education through practical activities. Additionally, through Presidential Decree PF-81, adopted on May 31, 2023, and the corresponding Resolution PQ-171, the powers of the State Committee of the Republic of Uzbekistan on Ecology, Environmental Protection, and Climate Change were expanded [2]. The

activities of this body, conducted in cooperation with the education sector, have become an important stage in fostering ecological values within school education.

Furthermore, Presidential Decree PF-199, announced on November 23, 2023, sets out tasks to implement ecological education at all levels, to include it as an independent subject in school curricula, and to establish a cluster for ecological innovations and technologies [3]. This highlights the need to introduce new scientific and practical directions for fostering ecological culture, particularly within the primary education system.

These legal documents underscore the urgent necessity of providing ecological knowledge in primary education on a methodological basis, teaching it through practical assignments, experiments, and project-based lessons. From this perspective, the methodological revision of ecological education in the teaching of natural sciences in grades III-IV is closely aligned with current educational policy.

The scientific and philosophical thought of Central Asia over millennia has been rich in ideas aimed at explaining the harmony between humans and nature and achieving ecological sustainability. The great scholars of this region not only made significant contributions to the development of science but also emphasized environmental issues in their works, such as attention to nature, rational use of natural resources, protection of land and water, and the conservation of flora and fauna. Their views can be recognized as one of the ideological foundations of modern ecological education.

In particular, Abu Rayhan Beruni, in his works on “Geodesy” and “Mineralogy,” provided a profound scientific justification of the interconnection between nature and human activity. He advocated achieving scientific truth through direct observation of nature and the analysis of empirical data. Beruni’s approach to the plant and animal world, the formation of geological strata, and the movement of groundwater reflects an ecological perspective, which positions his views not only as contributions to the natural sciences but also as a historical source for ecological education.

Additionally, Abu Ali Ibn Sina, in his Canon of Medicine and other works, emphasized not only human health but also the necessity of a healthy surrounding natural environment. According to him, the purity of air, water, and soil is a crucial factor for maintaining the health of the human body. Ibn Sina’s ideas directly correspond to modern fields such as ecological hygiene, air pollution control, and water resource protection.

Moreover, the astronomical and geophysical works of thinkers such as Ahmad al-Farghani, al-Khwarizmi, and Mirzo Ulugbek scientifically and theoretically examined phenomena on Earth and in the cosmos, their impact on living organisms, and climate changes. These scholars approached contemporary ecological problems-such as global warming and land degradation-from a historical and scientific perspective.

Studying the heritage of these great scholars and integrating their scientific views into natural science education allows for the development of ecological thinking in students. In particular, at the primary education stage, adapting these ideas to the lesson process helps expand students’ scientific worldview and fosters a sense of responsibility toward nature.

Today, the widespread use of the concept of “eco-pedagogy” and the integration of the sustainable development concept into ecological education highlight the importance of incorporating the ecological perspectives found in our historical and cultural heritage into modern teaching and methodological materials. The ecological ideas advanced by the scholars of Central Asia serve as a solid foundation for instilling ecological culture in students of grades III-IV within natural science lessons, based on national values.

From this perspective, the ecological views advanced by the scholars of Central Asia were not only rich in scientific and philosophical content but also distinguished by their practical

applications. For example, Mahmud al-Zamakhshari emphasized issues such as environmental cleanliness, compassionate treatment of animals, and the prevention of wastefulness in his works. This reflects the early formation of the concept of ecological ethics.

Al-Khwarizmi, on the other hand, sought to integrate mathematics with natural sciences to assess the impact of human activity on nature through a quantitative approach. The principles of precise measurement and modeling in his scientific work can be seen as a precursor to modern ecological monitoring and approaches for determining sustainability indicators.

Additionally, in the works of writers such as Nizami Ganjavi, the appreciation of nature and the idea of harmony between humans and the environment are expressed in poetic and aesthetic language. Their works are interpreted not only as literary achievements but also as tools for ecological education. Such a cultural approach demonstrates that ecological upbringing is not limited to biological knowledge alone, but is closely connected with general moral, aesthetic, and social values.

Today, international concepts of ecological education-for example, UNESCO's Education for Sustainable Development program-emphasize the complex analysis of environmental problems and the importance of a transdisciplinary approach. In this context, the ideas developed by Central Asian scholars provide a national and theoretical foundation for addressing contemporary ecological challenges.

Integrating these historical sources into the natural science curriculum for students in grades III-IV allows not only the development of ecological knowledge but also the expansion of their thinking within the framework of national identity. For example, using short text-based tasks, experiment-based activities, and interactive methods based on the views of scholars such as Beruni or Ibn Sina proves effective in teaching their scientific perspectives.

At the same time, this approach provides a foundation for developing competencies such as ecological thinking, critical thinking, observation, drawing conclusions, and moral responsibility in students. Such a multifaceted approach not only enhances the effectiveness of education but also contributes to the sustainable formation of ecological culture among the younger generation.

Ecological education in primary school plays a crucial role in shaping not only students' knowledge of the environment but also their values, attitudes, and sense of responsibility toward nature. Integrating historical and cultural heritage from Central Asian scholars such as Beruni, Ibn Sina, Al-Khwarizmi, and Nizami Ganjavi into the natural science curriculum allows students to develop ecological thinking within the context of national identity and moral values.

Modern pedagogical approaches, including problem-based learning, project-based activities, interactive methods, and multimedia resources, enhance students' practical skills, critical thinking, and ability to apply ecological knowledge in real-life situations. Furthermore, the legal and policy frameworks in Uzbekistan, emphasizing ecological education and sustainable development, provide strong support for systematic implementation.

Thus, a historically-informed, interdisciplinary, and practice-oriented approach to ecological education in grades III-IV not only deepens students' understanding of environmental issues but also fosters the sustainable development of ecological culture, critical thinking, and social responsibility, preparing the younger generation to contribute effectively to the preservation of nature and the promotion of sustainable development principles.

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