

The Methodology Of Forming Environmental Safety Principles In The Process Of Teaching Organic Chemistry

Saibova Fatima Saudullovna,
Jurakulova Sitora Erkin qizi,
Kurbonova Iroda
Navoi State University, Navoi, Uzbekistan

Abstract

This article analyzes the issues of forming environmental safety principles in the process of teaching organic chemistry. The main focus is placed on developing students' responsible attitude toward the environment and shaping ecological awareness by teaching the negative impact of organic substances (plastics, petroleum derivatives, synthetic compounds) on human health and nature. Within the framework of improving environmental education and sustainable development strategies in the Republic of Uzbekistan, teaching the safe use of organic chemical substances is considered one of the key tasks. This article presents scientific and practical recommendations for teaching the ecological properties of organic compounds through chemistry curricula, teaching methods, and laboratory practices in higher education institutions.

Keywords: Organic chemistry, environmental safety, plastics, petroleum derivatives, synthetic substances, ecological awareness, sustainable development, eco-education, interdisciplinary approach, student competence.

Introduction

In recent years, the “Concept of Environmental Safety and Sustainable Development in Higher Education” (2022) [1], adopted by the Ministry of Education of the Republic of Uzbekistan, has been recognized as an important document aimed at enhancing environmental knowledge and awareness in the national education system and integrating sustainable development principles into practice.

This concept is focused on harmonizing the educational process in higher education institutions with the principles of environmental safety, strengthening interdisciplinary integration, and fostering a spirit of ecological responsibility among students. The concept emphasizes that environmental safety and sustainable development must bring broad changes not only to the economic and social spheres but also to the education system. Therefore, it is essential to cultivate knowledge related to environmental safety within traditional

disciplines such as organic chemistry. Through the introduction of environmental education in higher education, students are expected not only to gain subject-specific knowledge but also to develop into responsible and environmentally conscious individuals.

Based on this concept, research is being conducted on revising teaching methodologies in organic chemistry in higher education institutions, effectively integrating environmental safety principles into the curriculum, and implementing modern laboratory practices and “green chemistry” principles. This, in turn, contributes to the preparation of qualified specialists who support Uzbekistan's environmental and economic sustainability. Today, global ecological issues — particularly environmental pollution, the problem of waste, and the limited nature of natural resources — pose serious challenges for humanity. In particular, products of the organic chemical industry such as plastics, petroleum derivatives,

synthetic substances, and their non-degradable residues are considered among the main sources of global environmental problems [2-3].

Therefore, addressing environmental safety issues in the education system — especially through the teaching of organic chemistry — has become a pressing matter. It is crucial to provide students with in-depth knowledge about environmental protection, the impact of chemical substances on nature, and the consequences of their use. Evaluating the ecological characteristics of organic compounds during the learning process, teaching their safe use and recyclability, and promoting green technology-based approaches contribute to the development of ecological awareness and responsibility among students [4].

In the Republic of Uzbekistan, achieving environmental sustainability, promoting waste-free and safe technologies, and raising ecological culture among the younger generation are among the key priorities of state policy. In particular, within the framework of the “Concept for the Development of Environmental Education and Upbringing” (2020) and the “Green School” initiatives, significant attention is being paid to deepening the teaching of environmentally-oriented subjects in general education schools. From this perspective, developing a methodology for teaching organic chemistry based on environmental safety principles is both relevant and practically significant.

This research arises from the abovementioned necessity and aims to effectively integrate the ideas of environmental safety into organic chemistry lessons, utilizing modern teaching technologies and methods to foster ecological responsibility and competencies among students [5].

Methodological Foundations of the Research

The methodological foundations of this study are based on modern pedagogy, environmental education, the methodology of teaching organic chemistry, and general didactic principles. The research employs approaches aimed at forming environmental culture, responsible attitudes, and practical skills among students by teaching organic chemistry in accordance with environmental safety principles.

First, a scientific-theoretical approach was applied to analyze the relationship between organic chemistry and environmental safety, substantiating their role and significance in the educational process. This approach allowed for identifying opportunities to study environmentally hazardous organic substances and adapt them to the educational curriculum [6-7].

Additionally, an interdisciplinary approach was utilized to integrate chemistry, ecology, and biology in order to develop comprehensive knowledge and understanding among students. This method ensures that students learn about organic substances not only in terms of their chemical properties but also in relation to their effects on human health and the environment.

The competency-based approach focused on developing students' practical knowledge and skills, independent thinking, and the ability to solve environmental problems. Through this, students acquire not only theoretical knowledge but also the ability to make sound decisions in real-life situations [8].

The research-based approach enabled students to study the ecological properties of organic chemical substances through independent investigation. Laboratory work, small projects, and experiments were used to develop students' scientific worldview and observation skills.

The information and communication technology (ICT) approach contributed to

enhancing students' ability to receive and analyze information while also making the educational process more interactive and effective. Virtual laboratories, environmental hazard analysis simulations, graphs, and visual materials served as essential tools for improving the quality of education [9].

An experimental-pedagogical approach was also employed in the study, where the developed methodology was tested in school settings to assess its practical effectiveness. Through this approach, the impact of the proposed methodological materials and teaching techniques on students' knowledge acquisition was evaluated [10].

Research Results and Discussion

The integration of environmental safety principles into the teaching process of organic chemistry in higher education institutions of the Republic of Uzbekistan is of increasing importance. The conducted research revealed that incorporating an environmentally oriented approach into the teaching of organic chemistry has a positive impact on developing students' ecological awareness, interdisciplinary thinking, practical skills, and understanding of sustainable development principles.

The study was carried out with the participation of 2nd- and 3rd-year full-time and evening program students of the Chemistry Department at Navoi State University. During the lessons, topics such as "Fundamentals of Green Chemistry," "Environmentally Safe Organic Synthesis," and "Polymers and Their Impact on the Environment" were studied in depth through laboratory work, practical exercises, and interactive seminars.

In particular, discussions conducted within the topics "Alkenes, Alcohols, Phenols, and Aromatic Compounds" and "Chemical Properties of Polymers" were significant in identifying the environmental risks posed by substances that are non-biodegradable,

toxic, and harmful to human health. As part of student-led environmental projects, participants proposed synthesis methods based on alternative bio-polymers, recyclable materials, and non-toxic solvents.

Moreover, laboratory sessions on "Methods of Organic Synthesis" included not only traditional techniques but also experiments that used environmentally safe ("green") reagents, aqueous reaction media, and energy-efficient methods in accordance with environmental safety standards. This approach fostered not only chemical knowledge but also ecological thinking and a culture of safety in the laboratory among students.

The research results demonstrated that environmentally focused lessons are met with high interest by students and significantly enhance their abilities to analyze independently, identify ecological problems, and propose scientific solutions. The integration of ecology-related assignments and projects, and their explanation through real-life applications, helps students connect their subject-specific knowledge with a sense of social responsibility [9].

The discussion revealed that to sufficiently address environmental safety issues in organic chemistry classes at higher education institutions, it is necessary to improve curricula, enhance laboratory facilities with eco-friendly equipment, and organize professional development courses on "green chemistry" for instructors.

In conclusion, the results of this study show that teaching organic chemistry based on environmental safety principles at universities in Uzbekistan contributes not only to developing academically competent but also environmentally responsible specialists. This approach combines both scientific and social dimensions of student development and supports the goals of sustainable development.

Conclusion

The integration of environmental safety principles into the teaching of organic chemistry in higher education institutions of our Republic is one of the urgent pedagogical tasks. The conducted research and experimental developments demonstrate that implementing environment-focused approaches within this subject allows for preparing students not only with deep theoretical knowledge but also with ecological awareness and practical responsibility.

Students' engagement in experimental and project-based work has activated their independent scientific-research activities and strengthened their competencies in solving environmental problems through chemical approaches. Additionally, the application of green chemistry principles in laboratory practices has increased students' attention to adopting safe, non-toxic methods.

Research findings indicate that teaching organic chemistry with a focus on environmental safety in higher education contributes to:

training environmentally conscious and responsible professionals;

linking chemical knowledge with real ecological issues;

strengthening interdisciplinary integration;

creating an educational model that supports sustainable development.

Based on this, methodological approaches focused on environmental safety must be supported across all higher education institutions through updated curricula, new laboratory methodologies, and modern ICT-based teaching resources. This, in turn, will serve to prepare innovative, environmentally aware, and scientifically capable specialists within the education system.

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