СУЧАСНА ПЕДАГОГІЧНА ОСВІТА: ПРОБЛЕМИ ТА ПЕРСПЕКТИВИ

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FORMATION OF ENVIRONMENTAL COMPETENCE IN STUDENTS WHEN STUDYING ORGANIC CHEMISTRY AT SCHOOL

Marianna Barus[1]
https://orcid.org/0000-0001-9447-6170,
Olga Skrypska[2]
https://orcid.org/0000-0001-7212-2929

Bogdan Khmelnitsky Melitopol State Pedagogical University[1],
Yuriy Fedkovych Chernivtsi National University[2]

The article highlights the possibilities of developing students' environmental competence during the study of organic chemistry in secondary education institutions. Emphasis is placed on integrating the principles of Green Chemistry, analysing the atom economy of chemical processes, and applying contextual tasks related to the environmental consequences of military operations in Ukraine. The role of chemical knowledge in ecosystem restoration and the implementation of sustainable development goals is substantiated. Environmental protection is particularly important at the current historical stage due to the growing severity of ecological problems. The main cause of environmental disasters is unconscious human behaviour. Modern generations often forget the need to achieve harmony with nature, being driven instead by a distorted system of values focused on increasing consumption, conquering nature and exploiting resources without reflection.

Key words: ecological competence; organic chemistry; Green chemistry; atom economy; military ecology.

Барус Маріанна, Скрипська Ольга. Формування екологічної компетентності в учнів під час вивчення органічної хімії в школі.
У статті розкрито можливості формування екологічної компетентності учнів під час вивчення органічної хімії в закладах загальної середньої освіти. Акцентовано увагу на інтеграції принципів «Зеленої хімії», аналізі атомної ефективності хімічних процесів та застосуванні контекстних завдань, пов'язаних із екологічними наслідками воєнних дій в Україні. Обґрунтовано роль хімічних знань у відновленні екосистем та реалізації цілей сталого розвитку. Питання захисту довкілля на сучасному історичному етапі досить важливе, оскільки спостерігається загострення екологічних проблем. Основною причиною екологічних лих та катастроф є проблеми несвідомої поведінки людей. Теперішнє покоління забуває про необхідність досягнення гармонії з природою, ним рухає не любов до всього живого, а перевернута шкала цінностей, що вимагає лише збільшувати споживання природних багатств, бездумно підкорювати та перетворювати природу.

Ключові слова: екологічна компетентність; органічна хімія; Зелена хімія; атомна ефективність; воєнна екологія.

Introduction. Ecological and environmental problems have become global in recent decades. Regional problems are increasingly expanding their scope. The armed aggression of the Russian Federation against Ukraine has caused numerous environmental disasters. Modern realities necessitate a rethinking of the content of natural science education, taking into account current environmental challenges. The updated chemistry programme for primary school (Chemistry. Grades 7-9. Programme for general education institutions with amendments, approved by Order of the Ministry of Education and Science of Ukraine dated 07.06.2017 № 804) outlines key competencies that chemistry teachers are designed to develop, including «Environmental literacy and healthy living» and «Basic competencies in natural sciences and technologies» (Velychko, 2017, pp. 2-5.) emphasizes that the content of all sections of chemistry should be oriented towards the formation of the competence "Environmental literacy and healthy life". The issue of ecologisation of knowledge about organic substances becomes particularly acute in conditions of martial law, when the destruction of industrial facilities leads to large-scale environmental pollution with oil products and toxic detonation products. The formation of

ecological competence allows students not only to understand the properties of substances, but also to assess their impact on the biosphere and think critically in crisis situations. Organic chemistry is an ideal platform for developing ecological competence, as it examines the anthropogenic impact on the biosphere (plastics, pesticides, surfactants).

The purpose of the article is to provide theoretical justification and develop methodological recommendations for the formation of students' environmental competence when studying organic chemistry through the prism of Green Chemistry principles and the wartime challenges.

To achieve the set goal, the following tasks are planned:

• To analyse the scientific and methodological literature on the issues of greening chemical education.

• Based on the analysis of theoretical aspects of the problem of greening the content of school education, to outline the possibilities for developing the competence of «Environmental literacy and healthy life» in students.

• To identify the key principles of Green Chemistry acceptable for implementation in the school course of organic chemistry.

• To develop examples of contextual tasks based on real environmental situations (pollution by petroleum products, toxicity of nitro compounds).

Analysis of recent research and publications. At the current stage of development of pedagogical science, a significant amount of theoretical and practical material has been collected that concerns environmental education and the upbringing of schoolchildren. Theoretical and practical aspects of environmental education of students of general education institutions in the process of studying the school chemistry course have been explored by Ukrainian researchers: (Burynska, 1998, pp. 18–20.), (Shcherbina, 2012, pp. 118-122.), (Grabovyi, 2015, pp. 49-60.), (Velychko, 2019, 192 p.), (Voronenko, 2013, p. 31.), (Lukashova, 2024, pp. 124-131.) and others.

The main positions of the researchers can be summarised as follows:

In the article by N. Burynskaya «The Environmental Component in the Content of School Chemical Education» (1998), ways of integrating environmental knowledge into chemistry teaching are considered. The author identifies specific approaches to the formation of students' environmental competence, in particular through the disclosure of the relationship between chemical processes and environmental problems. The environmental component should be inextricably linked with the study of chemical concepts. The environmental component is included in the content of school chemical education through the analysis of the impact of production, use and disposal of substances on nature. Training is aimed at developing the skills to predict the consequences of chemical influences, solve environmental problems and form environmentally appropriate behaviuor.

The article by A. Shcherbyna and V. Shcherbyna (2012) considers the methodology for forming the environmental culture of schoolchildren, which involves combining theoretical knowledge of chemistry with practical environmental activities, analysing the environmental friendliness of production processes of local industries in chemistry lessons. The authors highlight the possibilities of conducting thematic lessons and extracurricular activities to increase environmental responsibility, which is published in the «Scientific Notes of the NSU named after M. Gogol». They actively use business games, discussions, the method of environmental projects, scientific research work of students in the Academy of Sciences, etc.

In the article by A. Grabovoy «Formation of the ecological culture of schoolchildren in the process of studying chemistry» (2015), theoretical and practical aspects of environmental education within the framework of the school chemistry course are analysed. The author substantiates the methods of forming the ecological consciousness, behaviour and culture of students, aimed at understanding the relationships between chemical knowledge and environmental problems. The author emphasises that the ecological culture of students is formed during the study of chemistry due to the inclusion of the ecological component in the main course, the use of ecologised chemical experiments and the performance of chemical and ecological tasks.

N. Lukashova (2024) considers the directions of formation of readiness of future teachers of natural sciences to implement the ecological component of professional activity.

Research of a group of scientists under the leadership of N. Pustovit (2016) indicates the need to create an «ecologised educational environment». In the monograph «Ecologisation of the educational space of a modern comprehensive school» the authors emphasise the importance of going beyond biology and geography, integrating environmental issues into all subjects, in particular chemistry, and fostering a responsible attitude towards nature (Pustovit, 2016, 154 p.).

S. Tolochko (2024) in his monograph raises the urgent issue of the formation of environmental competence in the context of overcoming the consequences of war, which is a new, critically important vector for Ukrainian education. The work focuses on the importance of knowledge and active actions to restore the environment affected by hostilities, in particular through project and research activities and digital technologies (Tolochko, 2024, 160 p.).

Thus, the analysis of Ukrainian scientific and pedagogical literature indicates the transformation of approaches to the study of chemistry: from the simple study of «harm of chemicals» to the formation of holistic environmental competence in the context of Sustainable Development and Green Chemistry (Sustainable Development Goals and Ukraine

Cabinet of Ministers of Ukraine [Electronic resource] – Access mode: https://www.kmu.gov.ua/diyalnist/cili-stalogo-rozvitku-ta-ukrayina (access date: 5.02.2026).).

Therefore, the problem of forming students' environmental competence in the process of learning chemistry remains relevant.

Presentation of the main research material. The foundation of the modern concept of environmental literacy in the secondary education institutions system of Ukraine is the State Standard of Basic Secondary Education (2020) and the conceptual principles of the «New Ukrainian School» (2016). In these documents, «Environmental Competence» is defined as one of 11 key competencies.

Environmental competence is a person's ability to act situationally in everyday life and in the environment, making decisions based on acquired environmental knowledge, skills, values and experience, correctly performing actions and realizing responsibility for their decisions and their consequences for the environment (State Standard of Basic Secondary Education. [Electronic resource] – Access mode: https://mon.gov.ua/osvita-2/zagalna-serednya-osvita/nova-ukrainska-shkola-2/derzhavniy-standart-bazovoi-serednoi-osviti (access date 05.02.2026)).

Since modern environmental problems can be solved by joint efforts, everyone's environmental competence is important. It is important not to be afraid of the volume of the environmental information flow, but to be ready for action. Therefore, the main task of a chemistry teacher is to lead students to a correct assessment of the current state of the environment, to an understanding of the need for economical and careful use of natural resources. In addition, the chemistry teacher is tasked with revealing the dual role of the chemical industry in relation to nature, to equip students with practical skills and abilities that will contribute to their possible participation in environmental protection measures.

Organic chemistry covers topics that are directly related to modern environmental challenges – hydrocarbons, polymers, petroleum products, pesticides, plastics and other organic compounds. The study of these topics provides an opportunity to discuss environmental aspects: origin, use, impact on the biosphere, problems of utilisation and recycling.

When forming the ecological culture of students, the following methodological techniques are used:

• improving environmental education directly in the lessons (explanation of the impact of organic compounds on health);

• development and use of tasks and tasks of ecological content;

• ecologisation of a chemical experiment (use of micromethods, implementation of an eco-oriented chemical experiment);

• preparation of environmental projects (Research on the recycling of organic raw materials and household waste. Biodegradable polymers (polylactides) as an alternative to traditional plastics. Synthesis of starch-based bioplastics.);

• business games («Environmental expertise», «Find the mistake»);

• environmental monitoring (digitalisation of environmental monitoring, use of mobile applications and sensors for environmental analysis directly during the study of organic chemistry topics);

• use of interdisciplinary connections between chemistry and biology (toxic effects on enzymes), geography (distribution of pollutants with the flow of rivers) and other subjects;

• case methods: analysis of real environmental disasters (for example, oil spills) through the prism of chemical reactions.

Having analysed the school chemistry programme, we saw that environmental issues are introduced into the content of many topics of the organic chemistry course. Table 1 provides a list of cross-curricular ecological and chemical questions, the search for answers to which will contribute to the formation of students' ecological culture in organic chemistry (Berezan, 2018, 112 p.). At the same time, the problem of improving the environmental content of chemistry requires further research.

Table 1

List of some questions on the formation of students' ecological culture in organic chemistry (standard level)

Topic by program	***Environmental issues***
Theory of chemical structure.	Carbon as the basis of living nature and the relationship between living and non-living nature.
Applications of hydrocarbons.	Ecological aspects of the use of gaseous fuels in industry and everyday life. Biogas. Octane number and quality of gasoline. Smog as a chemical phenomenon. Environmental impact of hydrocarbons and their derivatives.

Topic by program	***Environmental issues***
Arenes. Chemical properties of benzene.	Organochlorine pesticides, their effect on living organisms. Requirements for toxic chemicals. Prevention of pesticide contamination of food products. Toxicological properties of benzene and toluene.
Natural sources of hydrocarbons and their processing.	Causes of environmental pollution by petroleum hydrocarbons, their effect on living organisms. Methods of refining petroleum products. Petroleum products as fuel. Problems of obtaining liquid fuel from coal and other alternative sources.
Alcohols and phenols.	Physiological effect of alcohols on the human body. Toxic properties of phenol. Environmental safety of obtaining and using phenol. Detection of phenol in green tea extract.
Esters. Fats.	Chemical composition of synthetic detergents. Their effect on living organisms. Consequences of water pollution of the SMZ. Ethers and esters in cosmetics.
Carbohydrates.	The ecological significance of the photosynthesis process. Photosynthesis and the solution of the energy problem. Biodiesel.
Polymers. Plastics.	The use of polymer products in everyday life. The impact of polymer materials on the environment and human health. The problem of recycling plastic waste. Manufacturing products from plastic bottles

Environmentally cultured schoolchildren should be aware of the need for complete waste disposal to avoid their accumulation and harmful effects on the environment and humans.

It is important to show students ways to solve pollution problems, namely: the creation of new and improvement of existing equipment and technologies; increasing the productivity of enterprises by increasing product yield and reducing the formation of production waste; developing waste disposal systems and switching to closed technological cycles; creating a recycled water supply that reduces the runoff of polluted water. When studying chemical production, it is necessary to reveal the basic ecological principles of modern production. In addition, it is necessary to show the importance of plants in the processes of improving the atmosphere and characterise protective zones around chemical facilities.

When considering environmental protection issues, students can be offered chemical-ecological questions and tasks. When compiling them, it is recommended to take into account the following methodological requirements:

1. The conditions and solutions of the tasks must contain practically significant information.

2. Applied information must be closely related to the material of the educational programmes and show real solutions to environmental problems.

3. The level of complexity of the tasks must be feasible for this class.

4. To solve the tasks, students must be able to rely on a complex of knowledge from different subjects.

5. Tasks can be used to explain information, verify, apply or improve knowledge.

At the initial stage of studying chemistry, ecological tasks are used to concentrate attention, develop curiosity and form interest. Ecological tasks at this stage are mainly illustrative in nature. Later, at the next stages of learning, cognitive tasks of a problematic nature are introduced.

The initial data for compiling tasks of an ecological nature can be obtained from textbooks, reference and popular science literature, articles and periodicals.

In search of answers to the questions of tasks or tasks, the student becomes directly involved in solving problems of nature protection, gets the opportunity to apply the acquired knowledge in real life.

Monitoring the process of solving such tasks by students gives the teacher an idea of the levels of intellectual development of schoolchildren, the formation of their ecological and chemical knowledge, cognitive interests and skills. Tasks that are solved in several possible ways allow the teacher to draw conclusions about the level of formation of students' environmental culture and adjust their pedagogical activities in this direction.

Ecologysation of chemistry experiment

The most important component of the school chemistry course is a chemical experiment, which plays a special role in studying environmental protection problems.

A chemical experiment is characterised by the performance of various didactic functions, use in various forms and combination with various methods and means of teaching. It is a system in which the principle of gradual independence of students works: starting from the demonstration of phenomena during a frontal laboratory experiment and continuing with independent work during practical work or solving an experimental problem, conducting a home experiment.

A school chemistry experiment can belong to one of four main types (or it can be intermediate):

- demonstration experiment;
- laboratory experiment;
- practical work;
- home experiment.

The authors (Grabovy, 2015, pp. 49-60) propose the following directions for the ecologisation of an educational chemical experiment:

1) explain natural phenomena through the performance of a chemical experiment;

2) develop an environmentally safe experiment;

3) use analytical methods to monitor the state of the environment;

4) study the impact of substances on living organisms and ecosystems;

5) recycle waste from school chemical experiments.

When a chemical experiment is used to explain natural processes and phenomena, emergency situations are simulated.

The environmental safety of the experiment can be achieved through the use of substances in small quantities, the development of projection and virtual chemical experiments, the use of devices – closed systems.

Through chemical experiments, it is necessary to familiarise students with methods of monitoring the state of the environment, waste-free production technology, rules for handling household chemicals, the harmful effects of substances on the human body, the harmfulness of alcohol, smoking.

When performing all types of chemical experiments in all classes, the idea of environmental protection should be significant. It is necessary for schoolchildren to realise that each experimental action must be environmentally friendly. And this can be achieved if we find ways to recycle waste from school chemical experiments and include in all school experiments without exception the stage of utilisation (destruction or neutralisation of substances, their direct or indirect reuse in the educational process). Thus, the chemistry room at school should be considered not only as a place of study. It is also a «place of action», a special «chemical production», which creates, among other things, harmful waste and requires that environmental protection requirements be implemented in the process of performing a chemical experiment. Such a view allows forming environmentally friendly thinking in students, to develop in them a «reflex of environmental cleanliness» in any of their actions (Shcherbina, 2012, pp. 118-122).

Formation of competence in environmental literacy during the implementation of educational projects in chemistry

The use of the educational project method increases students' motivation to gain knowledge, creates the prerequisites for their creative self-realisation, and promotes the development of intellectual abilities. That is why this method is currently a promising type of educational activity. The project presents problems that, thanks to the experience gained, students will be able to solve even in real conditions of future independent life (Zagnybida, 2011, 128 p.). An educational project assigned according to the topics specified in the chemistry programme can and should be considered from an ecological point of view. The student must understand the direct dependence of his health and well-being on his lifestyle and attitude to the environment. Each student must learn to feel his involvement in what is happening around him, be able to make responsible decisions, and act, remembering his duty to nature.

Thanks to the method of environmental projects, students develop a creative approach to learning about nature, assessing the environmental situation, and become able to identify, analyse, and assess the impact of anthropogenic factors on the environment, predict changes, and propose their own solution to environmental problems. Environmental projects contribute to the development of environmental awareness among students and the formation of environmental competence.

Each project should raise the following questions, which will need to be answered and on the basis of which students will draw conclusions:

- How will the results of the research affect the creation of a harmless environment for yourself, other people and the environment?

- How can the results of the work be linked to the need to adhere to a healthy lifestyle?

- Is the interaction between man and nature revealed and what is its nature?

- Are environmental risks assessed and are ways of solving environmental problems of the environment proposed?

The first educational project specified in the chemistry programme in grade 7 – «Chemicals around us» – is a vivid example of an educational project of an ecological orientation. It is clear to everyone that it is necessary to study substances not only from the perspective of the characteristics of their physical and chemical properties, but most importantly, the impact of this substance on human health and the environment in general. It is impossible to ignore the biological effect of the substance under consideration on the body; the place of the substance in the large and small cycle of substances, and, in general, the study of the question of whether inclusion is possible, whether there is a place for this substance in nature? The student must understand that the emergence of new synthetic substances requires the development of ways of its decomposition and utilisation of decomposition products by microorganisms. Otherwise,

environmental pollution occurs, which always leads to a deterioration in its ecological state. In addition, when implementing this project, there is an opportunity to expand the content of the laboratory experiment and familiarise yourself with the labeling of not only hazardous, but also any substances that the student encounters during cooking, in everyday life, on the garden plot, etc. The result of the activity will be a conscious choice of food products, household chemicals, etc., considering their impact on personal health and the environment (Sunday, 2026, pp. 122-123).

Table 2 lists the names of projects that can be implemented while studying organic chemistry.

Table 2

Project activities in organic chemistry as a means of forming environmental competence of students of secondary education institutions

№ in order	***Project name***	***Section (topic) of organic chemistry***	***Description of the project content***
1.	Organic solvents: benefit for humans or threat to the environment?	Alcohols; ketones; aromatic hydrocarbons	Analysis of the physicochemical properties of organic solvents, their toxicity and impact on the environment
2.	Organic polymers and their biodegradability	Polymers; macromolecular compounds	Comparative analysis of synthetic polymers and natural biopolymers, the problem of plastic pollution
3.	Detergents and surfactants: organic chemistry of cleanliness	Carboxylic acids; esters; surfactants	Study of the composition of detergents and the impact of surfactants on aquatic ecosystems
4.	Organic acids in nature and food products	Carboxylic acids	Study of the distribution of organic acids in nature, their biological role and environmental safety
5.	Fuels of organic nature: chemistry and ecology	Hydrocarbons; alcohols	Comparative characteristics of traditional fuels and biofuels, analysis of combustion products
6.	Pesticides as organic compounds: environmental risk	Hydrocarbon derivatives; halogen derivatives	Analysis of the mechanisms of action of pesticides, the problem of bioaccumulation and toxicity
7	Organic dyes: beauty or danger?	Aromatic compounds; azo dyes	Assessment of the impact of synthetic dyes on aquatic ecosystems and human health
8	Medicines as organic compounds: the path from benefit to pollution	Organic functional groups	Study of pharmaceutical pollutants and their routes of entry into the environment

The implementation of such projects involves the formation of a system of environmental knowledge, the development of practical skills of environmentally appropriate behavior and awareness of the importance of environmental protection.

Currently, much attention is paid to the implementation of Green Chemistry principles in the educational process. Systematic reviews show that the Green Chemistry principles can be used to increase students' environmental literacy, as they allow considering chemical processes in the context of sustainable resource use, waste minimisation and pollution prevention (Koulougliotis, 2024, 7052. https://doi.org/10.3390/su16167052; Sunday, 2026, pp. 122-123; Savchyn, 2020, pp. 68-70).

The introduction of the Green Chemistry principles into the educational process of secondary education institutions is not just a change in educational content, but a transition to a new philosophy of thinking. In the context of modern environmental challenges, in particular those caused by military actions in Ukraine, organic chemistry ceases to be a set of abstract formulas and becomes a tool for sustainable development.

Traditional organic chemistry in schools often focuses on synthesis methods without considering their energy consumption or the toxicity of by-products. Green Chemistry is based on 12 principles that offer a radically different approach.

The following areas are key for general secondary education institutions:

1. Atom Economy: In contrast to the classical concept of «product yield», this principle teaches how to calculate what fraction of the reactants atoms have gone into the final target product. This mathematically justifies the choice of more rational synthesis routes.

2. Replacement of toxic solvents: The study of the solubility of organic compounds can be combined with a discussion of the transition from chloroform or

benzene to safer alternatives, such as water or ethanol.

3. Use of renewable raw materials: This is the foundation for studying the topics «Hydrocarbons» and «Natural sources of hydrocarbons». Students learn to compare exhaustible resources (oil, gas) with biomass and agricultural waste, biodegradable plastics and polyethylene.

The principle of atom economy (AE) is a concept in Green Chemistry that aims to maximise the incorporation of all atoms of the starting reactants into the final target product. The goal is to minimise waste generation by reducing the number of by-products and increasing the economic and environmental feasibility of the reaction. In contrast to the traditional calculation of product yield, AE teaches students to evaluate the «wastelessness» of a reaction. AE is defined as the ratio of the molecular mass of the target product to the sum of the molecular masses of all reactants.

Examples of calculation problems for assessing the environmental friendliness of chemical synthesis.

1. Ethyl acetate is an important organic solvent. In industry and laboratories, it can be obtained by two main routes: esterification reaction and catalytic dimerisation of ethanal (Tyshchenko reaction). Calculate the atom economy (AE) for each method and conclude which of them is more consistent with the principles of Green Chemistry.

2. Calculate the AE of ethanol synthesis by hydration of ethylene. Why is this method considered «greener» than glucose fermentation in terms of atom economy? (Hint. Disadvantage of the second method: During glucose fermentation, a significant amount of carbon dioxide is formed, although the raw material is renewable. Discussion of the carbon footprint).

3. To obtain phenol, the cumene method (oxidation of isopropylbenzene) is used. The products are phenol and acetone. Calculate the AE relative to phenol. How will the efficiency of the process change if acetone is also considered a target product?

4. Compare the AE of two methods of producing methanol: the first method is from synthesis gas; the second is from methane, through its chlorination and hydrolysis of the chlorination product (consider all reagents and by-products).

5. The synthesis of acetic acid by the carbonylation of methanol is called «ideal» from the point of view of Green Chemistry. Prove this by calculating AE.

6. Imagine that biodegradation is used to clean the soil from fuel residues at the site of an oil depot attack, where the final products are carbon dioxide and water. Is it appropriate to use the concept of AE in this context if the target result is not a substance, but a clean environment?

7. Calculate the AE of the esterification reaction between acetic acid and isoamyl alcohol (pear essence is formed). Where do the «lost» atoms go and how does this affect the ecological footprint of production? Indicate ways to increase the yield of ester. (Hint. The esterification reaction is a reversible process and is carried out using a catalyst. The effect of removing water from the reaction mixture to shift the equilibrium. Carrying out the reaction without using excess reagents).

8. Biodiesel production is based on the transesterification of oil triglycerides with methanol. The products are biodiesel (methyl esters) and glycerol. Calculate the AE of the process relative to the fuel.

9. When trinitrotoluene detonates, a large amount of solid carbon (soot), carbon monoxide, and water is formed. Calculate what percentage of the reactant atoms are converted to toxic carbon monoxide. How does this correlate with the principle of Green Chemistry about minimising harmful products? Explain why the products of their incomplete decomposition are persistent organic pollutants.

10. In Ukraine, soil restoration is being discussed through the cultivation of industrial crops (rapeseed) for the production of bioplastics (polyesters). Calculate the theoretical AE of the polymerisation of lactic acid into polylactide (PLA), where a water molecule is released for each link.

Therefore, the study of organic chemistry should not be limited to knowledge of the properties of substances. The main goal is the formation of environmental literacy: the student must realise that any chemical process must be safe «from conception to disposal». It is necessary to change the approach to the use of synthesis methods. Preference should be given to those methods that will produce less waste, the waste will not be toxic, the synthesis will take place at room temperature and normal pressure, the catalyst used will be not just a means of accelerating the reaction, but also as a means of reducing the number of unwanted by-products.

«Green chemistry in school programme is not an additional section, but a cross-cutting line that transforms chemistry from a «test tube science» to a science of survival and well-being of humanity» (Koulougliotis, 2024, 7052. https://doi.org/10.3390/su16167052; Sunday, 2026, pp. 122-123; Savchyn, 2020, pp. 68-70).

Thus, Green Chemistry creates a modern scientific field where organic chemistry is transformed into an applied discipline capable of solving global and local humanitarian and environmental problems.

Research on methodological works emphasises the importance of including tasks with an environmental component in chemistry teaching as one of the effective ways to form environmental

competence. This can be implemented through tasks on pollution, disposal, assessment of the impact of chemicals on the environment and health. When studying oxygen-containing organic compounds, one should solve tasks that assess the consequences of environmental pollution in the event of damage to chemical enterprises and the ingress of waste into the ecosystem. For example, students are invited to calculate the risks of contamination of water bodies with phenol in the event of damage to chemical enterprises, comparing the obtained data with the MPC standards, since even a small amount of phenol can poison an entire reservoir. Another example is to calculate the percentage of extracted oil that enters the world ocean, to assess the environmental damage from oil spills.

Chemical knowledge should be «attached» to real-life situations. For example, when studying alcohols, consider methanol and ethanol not only as solvents, but as alternative fuels, and glycerol as a raw material for producing biodegradable bioplastics, instead of throwing it into wastewater, where it causes bacterial growth and oxygen deficiency. When studying the topic of aldehydes, the teacher should draw students' attention to the fact that formaldehyde, which is a carcinogen, is used in the production of furniture.

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When studying the topic «Hydrocarbons», it is advisable to focus students' attention on the environmental consequences of the release of oil refining products and fuel into the environment. In particular, aromatic hydrocarbons, which are formed as a result of incomplete combustion of fuel, are characterised by high toxicity, stability and ability to bioaccumulate, which causes long-term pollution of ecosystems. Consideration of the chemical structure of these compounds allows explaining the reasons for their carcinogenic properties and danger to living organisms.

The study of organic chemistry through the prism of «green» technologies allows us to more deeply analyse the consequences of war. For example, the topic «Petroleum products» can be considered not only as a source of fuel, but also through methods of soil purification. The use of hydrocarbon-destructive bacteria or «green» sorbents (for example, based on modified cellulose) demonstrates the effect of the principle of decomposition into safe substances.

The topic of «Nitrocompounds» in the context of explosives allows discussing the toxicity of their decomposition products and the importance of developing an «eco-explosive» that would not acidify soils with nitric acid.

When studying alcohols, ketones and other organic solvents, it is advisable to reveal the mechanisms of their distribution in the environment, due to their high volatility and solubility in water. As a result of hostilities, technical liquids and solvents easily enter water bodies, causing toxic effects on aquatic organisms and disruption of natural biochemical processes. This approach helps students understand the relationship between the physicochemical properties of organic compounds and the scale of their environmental impact.

The topic of «Polymers» requires special attention, since the destruction of infrastructure and military equipment is accompanied by the accumulation of polymer waste. The high chemical stability of polymers, due to the peculiarities of their macromolecular structure, leads to the long-term preservation of these materials in the environment and the formation of microplastics, which pose a threat to living organisms and trophic chains.

When studying halogenated hydrocarbons, it is advisable to pay attention to their increased toxicity and stability, which is largely due to the presence of halogen atoms in the molecule. The release of such compounds due to fires or the destruction of industrial facilities can have long-term negative consequences for ecosystems and public health.

An example of a project that can be implemented: «The Path of a Toxin». Task: Trace the chain: explosion → combustion products entering groundwater → accumulation in plants → entry into the human body.

Thus, the integration of information about the environmental consequences of military operations into the process of explaining organic chemistry material contributes to the formation of a holistic understanding of the practical significance of chemical knowledge in students, the development of ecological thinking and a responsible attitude to the environment. This approach ensures the implementation of a competency-based approach in

teaching chemistry and increases students' motivation to study the subject.

Conclusion. The formation of environmental competence in organic chemistry lessons is ensured through the integration of the scientific principles of Green Chemistry and the updating of educational material to the challenges of today. The use of the atom economy index and the analysis of real environmental cases of the war era allows turning chemistry into an effective tool for environmental education. This contributes not only to better mastering the subject, but also prepares conscious citizens capable of environmental restoration of the country.

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Відомості про авторів:
Барус Маріанна Маринівна
marianna.barus@mspu.edu.ua
Мелітопольський державний педагогічний університет імені Богдана Хмельницького
Наукове Містечко, вулиця, 59, Запоріжжя, Запорізька обл., 69000, Україна

Скрипська Ольга Василівна
o.skrypska@chnu.edu.ua
Чернівецький національний університет імені Юрія Федьковича
Коцюбинського, вулиця, 2
Чернівці, Чернівецька обл., 58002, Україна

Information about the authors:
Barus Marianna Marynivna
marianna.barus@mspu.edu.ua
Bogdan Khmelnitsky Melitopol State Pedagogical University
Scientific Town, Street 59, Zaporizhzhia, Zaporizhzhia region, 69000, Ukraine

Skrypska Olga Vasylivna
o.skrypska@chnu.edu.ua
Yuriy Fedkovych Chernivtsi National University
Kotsiubynsky Street, 2
Chernivtsi, Chernivtsi region, 58002, Ukraine

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