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The Implementation of Environmental Knowledge in Science Education

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A B S T R A C T

A person of the XXI century is already accustomed to digging out any truth through convincing scientific evidence, through knowledge. Therefore, in the formation of environmental consciousness of young people, the most important role should belong to science. High grade studentsare able to effectively assimilate environmental knowledge included in the content of traditional school chemistry and biology. In chemistry lessons, it is possible to vividly and convincingly demonstrate both the negative aspects of human intervention in the natural environment and optimize anthropogenic influences on it.

The necessary examples revealing the chemical side of the interaction between society and the natural environment can be found in various scientific and popular science books devoted to the consideration of environmental problems. However, the effective use of environmental chemistry lessons requires a teacher to work with literature and adapt it to the school curriculum. Work on the problem of ecologization of the school science course is relevant and requires special study, because the system of environmental knowledge is formed not only traditionally in the biology course, but also in the process of studying the chemistry course.

Along with traditional biological ecology, which studies the relations between organisms and environmental conditions at the level of individuals, populations, biocenoses, and ecosystems, it includes applied ecology (industrial, urban, agricultural, forest ecology, etc.) and social ecology (the relationship between nature and society). Such a wide range of environmental problems has led the fact, of ability of teachers in integrating the subject in the context of environmental education has become widespread.

In chemistry lessons, it is most appropriate to study issues related to chemical pollution of the environment, to get acquainted with methods of pollution monitoring and ways to reduce its harmful effect on living organisms, including humans. A chemistry teacher can professionally discuss with students new low waste technologies, methods of purification of liquid effluents and gas emissions, as well as the problem of solid waste disposal; to consider the biospheric cycles of substances and the consequences of human influence on them (increased greenhouse effect, destruction of the ozone screen, transboundary transport of pollutants, acid rain), chemicalization of agriculture, energy problems using carbon energy carriers and hydrogen.

Keywords: science education, ecology green chedmistry, teaching, innovative teaching

Introduction

The problem of the formation of environmental consciousness is extremely important in the conditions of man's isolation from his environment, in the era of the dominance of the values of technogenic civilization, which have fenced man off from nature with a powerful shield. The consequence of this is an ongoing environmental crisis (Alla, 2021). The deterioration of the quality of the environment, in the end, leads to a social crisis, which consists in a decrease in the birth rate of healthy children, an increase in the incidence of diseases in the risk zone. As a result, the quality of life of both individual families and regions falls, because most of the money in the environmentally unfavorable living space is spent by a person on medicines. Thus, there is a direct dependence of the quality of the social environment on the quality of the ecological space (Yimuranzi et al., 2023). Two factors are a condition for the formation of environmental consciousness: environmental education in the family and environmental education.

A person of the twenty-first century is primarily a rationalist. He is already accustomed to digging out any truth through convincing scientific evidence, through knowledge. And, therefore, in the formation of environmental consciousness of young people, the most important role should belong to science and, first of all, to the natural sciences (Ha Pham Thanh et al., 2022). High school students are able to effectively assimilate environmental knowledge included in the content of traditional school subjects, especially biology, chemistry, geography. And if it is easier to talk about traditional biological ecology in biology lessons, then chemistry lessons open up a wide opportunity to explain the knowledge that is represented by modern global ecology, human ecology (Cooke et al., 2021). In chemistry lessons, it is possible to vividly and convincingly demonstrate both the negative aspects of human intervention in the natural environment and possible ways to optimize anthropogenic influences on it ()Quiroz-Martinez Denis, 2024).

The necessary examples revealing the chemical side of the interaction between society and the natural environment can be found in various scientific and popular science books devoted to the consideration (Thomas et al., 2018 and Holmstrup et al. 2010). However, the effective use of environmental

knowledge in chemistry lessons requires the teacher to work with literature and adapt it to the school curriculum. Work on the problem of ecologization of the school chemistry course is relevant and requires special study, because the formation of a system of environmental knowledge takes place not only traditionally in the course of biology, but also in the process of studying the course of chemistry (Tyler et al., 2022). The system of environmental education and upbringing is united in accordance with the Law of the Republic of Azerbaijan "On environmental education and public awareness" (https://e-qanun.az/framework/1880) a set of environmental educational programs (basic and additional) and state educational standards for basic and secondary education. The essence of environmental education can be understood through the characteristics of its main goals: the development of environmental consciousness and thinking, the ecological culture of the individual and society, the responsible attitude of each person to nature; the formation of practical experience in environmental management and competent decision-making (by everyone at their own level), which will contribute to a healthy lifestyle of people, sustainable socio-economic development and environmental security of the country and the world (Liopiz et al. , 2024).

Environmental education is understood as the process of forming a person with a conscious perception of the environment, awareness of the need to preserve nature, it is advisable to use its riches, and an understanding of the importance of increasing natural resources (Kaiko et al., 2022). Environmental education is based on such principles as systematicity, continuity, interdisciplinarity, interconnection of global, national and local history approaches (Putilova et al., 2023). The goal of environmental education is to make a person realize his unity with nature, with living space and perceive himself not as the king of nature, but as a part of it. Environmental education also involves the formation of a value-based attitude to nature. This is the axiological function of environmental education. Nature is not a resource, but a value, first of all aesthetic, then biological, but in no case non-utilitarian. Only the formation of an aesthetic attitude to nature can preserve it. If the biological value of nature as the basis of human existence as a biological organism is placed in the first place in the hierarchy of values, then the effect of environmental education will be different – the object of environmental education may not have an aesthetic perception of nature, without which a careful attitude to it is inconceivable. Modern ecology is a vast interdisciplinary science. Along with traditional general (biological) ecology, which studies the relationship between organisms and environmental conditions at the level of individuals, populations, biocenoses, and ecosystems, it includes applied ecology (industrial, urban, agricultural, forest ecology, etc.) and social ecology (the relationship between nature and society). Such a wide range of environmental problems has led to the fact that there is no special subject "Ecology" in schools, and the experience of teachers in integrating the subject in the context of environmental education has become widespread. In this case, almost all subjects make up a single educational ecological space (Crina et al., 2019).

The purpose of this study is to generalize and systematize the ways of applying environmental knowledge in natural science education, especially chemistry.

Investigation

Environmental education as the second factor in the formation of environmental consciousness consists in the inclusion in the curricula of secondary, secondary specialized and higher educational institutions of socio-ecological disciplines: social ecology, human ecology - the purpose of which is to reveal modern socio-ecological problems and designate ways out of the current crisis. Often, the modern generation not only does not think about the environmental threat to its existence, but is also unaware of it. Moreover, modern youth is captive to technogenic civilization and is ready to do anything for the sake of owning new gadgets. This is a manifestation of the crisis of technogenic civilization. In chemistry lessons, it is most appropriate to study issues related to chemical pollution of the environment, to get acquainted with methods of pollution monitoring and ways to reduce its harmful effect on living organisms, including humans.

In this study, we have summarized and systematized the ways of applying environmental knowledge in teaching chemistry, in order to motivate modern chemistry teachers to regularly educate students in their lessons. As mentioned above, this is an important step in the formation of an environmentally literate personality.

A chemistry teacher can professionally discuss with students new low-waste production technologies and methods for purifying liquid effluents and gas emissions, as well as the problem of solid waste disposal; to consider the biospheric cycles of substances and the consequences of human influence on them (increased greenhouse effect, destruction of the ozone screen, transboundary transfer of pollutants, acid rain), chemicalization of agriculture, problems of energy using carbon energy carriers and hydrogen. Some of these issues are also studied in the courses of other subjects included in the educational ecological space, these are biology, physics and geography. However, these inevitable elements of duplication of material are even useful, because they allow students to look at the same problem from different angles and positions. Let's consider the "share" of environmental problems that falls on chemistry. This "share" includes issues of general, applied and social ecology, although applied ecology (industrial, urban and agricultural) is most fully represented. Questions of general ecology are considered only in the study of chemical processes and energy flows in the ecosystem, as well as in the characterization of the circulation of substances in the biosphere, and questions of social ecology are considered in the discussion of the influence of chemical factors on human health. The environmental component in chemistry lessons is shown in Fig.1.

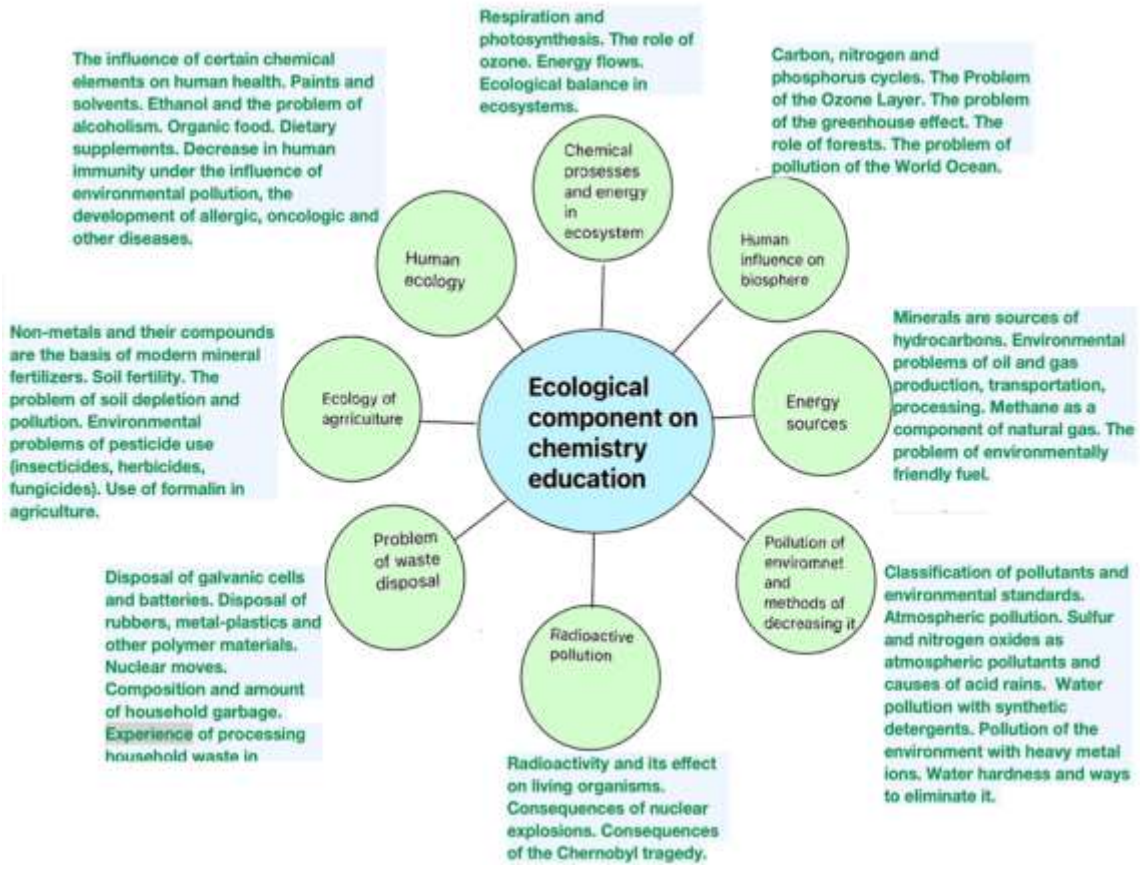

Fig. 1. Ecological component in chemistry education

The content of the environmental component is consistently developed in chemistry lessons from grades 7 to 11, while the same environmental issue can repeatedly pass through different sections of chemistry with a consistent deepening and expansion of the content. Each new appeal to the question is based on the actualization of previously acquired knowledge. Thus, the central question of the environmental component of chemistry.

Here is an example of the integration of ecology and chemistry in the 9th grade, where the course of organic chemistry on the topic "Hydrocarbons" is studied. The course of organic chemistry is quite difficult to perceive and assimilate. Students often lose interest in it after the first topic. However, it is difficult to overestimate the ideological importance of the study of organic substances, which make up the entire natural world of the Earth and each of us. Ecologization of the course of organic chemistry can introduce the student to this world "from the inside" and reveal not only the features of the structure and properties of biomolecules, but also the problems that arise for living organisms, individual ecosystems and the biosphere as a whole.

The study of the course should begin with the identification of the features of the carbon atom. As a true biophile, carbon has a small atomic mass, a small radius, and the ability to form multiple bonds. It is the only element that can keep single, double, and triple bonds in circuits at the same time. Covalent bonds between carbon atoms ensure the stability and self-preservation of various complex structural formations with a large energy reserve in them, which is very important for the life of organisms. In addition to strength, molecules based on carbon atoms are also mobile, flexible and can geometrically adapt to each other. Rotations from separate groups in molecules without breaking C–C bonds (conformational mobility) determine the properties of polymers. Energy is transferred through chains of conjugated bonds in biomolecules. In addition, if there are more than five conjugated bonds in the co chain, then such molecules absorb the light of the visible part of the spectrum and acquire color. Students may be very interested in information about the regularities reflecting the relationships in the system "structure - properties" on the example of the manifestation of toxicity by a substance. Thus, in the homologous series, the strength of the narcotic effect and the toxicity of substances increase with an increase in the number of carbon atoms in the molecule, and the branching of carbon chains weakens the narcotic and toxic effect; On the contrary, when the circuit is closed, the toxicity of substances increases. In addition, the presence of multiple bonds increases the chemical activity of organic compounds, which in turn not only causes an increase in narcotic and toxic effects, but can change the nature of the effect of the substance, for example, such a compound has an irritating effect.

Knowledge of these patterns will help students to take a more meaningful and purposeful approach to the analysis of the structures of organic compounds and, if possible, to predict their properties from the standpoint of their impact on living objects of nature.

When discussing the use of methane to produce hydrogen, students can independently name the method of high-temperature conversion of methane with carbon monoxide (IV):

$$CO_2 + CH_4 \rightarrow 2CO + 2H_2.$$

One of the products of the reaction is toxic carbon monoxide, a dangerous pollutant of the atmosphere. An effective way to neutralize it is catalytic oxidation (Cr, Zn, Cu catalysts):

$CO + H_2O$ (vapour)$\rightarrow CO_2 + H_2$

The carbon (IV) oxide formed during the reaction is absorbed by water or alkali. Students are asked to justify why methane in large concentrations is life-threatening, and then explain what the dual role of methane in nature is.

When characterizing freons, it should be pointed out that these gases or light-boiling liquids have a unique set of properties: chemically inert, non-flammable, non-explosive, non-toxic, insoluble in water and soluble in organic solvents. The use of freons has opened up new opportunities for storing food in industrial and household refrigerators. A few years ago, a hypothesis was put forward about the adverse effects of freons (especially CF_2Cl_2 и$CFCl_3$) on ozon layer. It is believed that freons decompose under the influence of ultraviolet solar radiation with the formation of a large number of various compounds and radicals. In the presence of atomic oxygen, radicals can catalyze the reactions of atoms and radicals with ozone molecules: Calculations show that the rate of formation of chlorine atoms should be maximum at an altitude of about 30 km. About blematic. Nevertheless, in a number of countries, it was decided to reduce the production of freons, and subsequently completely stop it. For example, less volatile fluorochloromethanes can be used as refrigerants, and liquefied gaseous paraffins can be used in aerosol packages.

When considering haloalkanes, you can offer students additional information about the physiological effects of some of them, for example, chloroform and dichloroethane. Chloroform, by the nature of its action, is a drug that causes metabolic disorders and damage to internal organs, especially the liver. With slight poisoning, vomiting, stomach pain, and impaired cardiovascular activity occur. In severe poisoning, there is a weakening of breathing, a decrease in body temperature, deep anesthesia. Chronic exposure to chloroform in small concentrations causes dermatitis, eczema, gastrointestinal disorders, changes in the liver. Dichloroethane acts as a drug, and in terms of the strength of the narcotic effect it ranks first. It mainly affects the liver. With mild poisoning, headaches, dizziness, nausea, slowing of the pulse, and a slight enlargement of the liver appear. In severe acute poisoning, these manifestations are more pronounced. Death is possible. In chronic poisoning, liver damage is observed, accompanied by jaundice coloration of the mucous membranes and skin. Dermatitis occurs in contact with the skin.

The production of acetylene from methane is associated with economic and environmental problems. Analyzing the method of oxidative cracking of methane, the attention of students is drawn to the fact that the heat spent on the endothermic reaction of acetylene formation is obtained due to the combustion of methane in special furnaces, where acetylene is formed at a temperature of 1600-2200ºC:

In addition to acetylene, a mixture of carbon monoxide (II) and hydrogen is formed, which is a synthesis gas - a valuable raw material for chemical synthesis (for example, methanol). It is noted that one of the promising methods for obtaining acetylene and hydrogen from methane is plasma-chemical, which is characterized by a complete absence of soot formation and low electricity consumption.

When studying aromatic compounds, the attention of students is drawn to their high toxicity. Benzene has a general toxic and carcinogenic effect, affects the reproductive function of women. It affects the kidneys, liver, changes the blood formula (reduces the number of leukocytes, platelets, red blood cells), disrupts the structure of chromosomes. Nitrobenzene also has a general toxic effect. It causes jaundice of proteins, physiological and neurological disorders.

Conclusion

In the process of environmental education in chemistry lessons, students who perceived chemistry as a purely theoretical, not related to life subject, will receive additional motivation to learn. Environmental education and upbringing, as a new area of pedagogy and school practice, is actively developing at the present time. It covers all areas and cycles of academic subjects. However, chemistry lessons have a significant role to play. The use of environmental material together with program material activates interest in the subject, develops the need to communicate with nature, fosters responsibility in personal behavior and various activities, forms skills for the careful use, protection and improvement of the environment. Everyone needs chemical knowledge in the system of environmental education. The foundations of a responsible attitude to the environment should be laid throughout all years of education.

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