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Абай атындағы Қазақ ұлттық педагогикалық университетінің

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НАУК РЕСПУБЛИКИ  
КАЗАХСТАН  
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**DEVELOPMENT OF ENVIRONMENTAL KNOWLEDGE  
OF STUDENTS BASED ON THE INTEGRATION OF PHYSICS  
AND BIOLOGY LESSONS**

**Abstract:** The article defines the scientific and pedagogical foundations of environmental education and upbringing at the present stage, a brief analysis of studies on environmental education of students in the study of physics in high school. Strengthening the ecological aspect and the role of the course of physics and biology in revealing the unity of nature and the environment, interpreting the role of physical laws and phenomena in the environment are of decisive importance for the younger generation, which will be connected to the production environment in the future. In the teaching of physics, the content of environmental education is determined in accordance with the achievements of science and technology, the transformation of training sessions is carried out, environmental education and culture of students are improved, and practical skills are improved. The new didactic foundations of environmental training of students in the study of physics in secondary school and the importance of interdisciplinary communication in improving environmental knowledge are considered. The possibility of implementing interdisciplinary connections and developing students' critical thinking skills in the formation of environmental knowledge through integrated teaching of physics and biology is proposed. The purpose of the work is to provide scientific and theoretical justification and methods of environmental education of students by teaching natural sciences. This paper provides for the development of environmentally friendly technologies in the teaching of physics in a modern school, based on the socio-economic conditions

corresponding to the development of modern science and technology. On the basis of interdisciplinary communication, relevant for modern schools as a condition for the comprehensive development of students' personality, the curriculum of the conference based on environmental education in natural sciences was developed and implemented in the practice of secondary schools. The article will interest scientists, methodologists, as well as everyone who participates in the modernization of modern society.

**Key words:** environment, environmental literacy, integration, physics, interdisciplinary communication.

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### **ФИЗИКА ЖӘНЕ БИОЛОГИЯ САБАҚТАРЫН КІРІКТІРУ НЕГІЗІНДЕ ОҚУШЫЛАРДЫҢ ЭКОЛОГИЯЛЫҚ БІЛІМДЕРІН ДАМУ**

**Аннотация.** Мақалада қазіргі кезеңдегі экологиялық білім мен тәрбиенің ғылыми-педагогикалық негіздері анықталып, орта мектепте физика курсына оқытуда оқушыларға экологиялық білім беру бойынша зерттеулерге қысқаша талдау жасалған. Табиғат пен қоршаған ортаның бірлігін ашудағы физика мен биология курсының экологиялық аспектісін және ролін күшейту, физикалық заңдылықтар мен құбылыстардың қоршаған ортадағы ролін түсіндіру болашақта өндіріс ортасына қосылатын жас ұрпақ үшін өте маңызды. Физиканы оқытуда ғылым мен техниканың жетістіктеріне сәйкес экологиялық білімнің мазмұны анықталып, оқу сабақтарының түрлендіріліп жүзеге асырылса, онда оқушылардың экологиялық білімі мен мәдениеті артып, практикалық дағдылары шындалады. Орта мектепте физиканы оқып білуде оқушылардың экологиялық дайындығының жаңа дидактикалық негіздері қарастырылып, экологиялық білімді жетілдірудегі пәнаралық байланыстың маңызы туралы қарастырылған. Физика және биология пәндерін кіріктіріп оқыту арқылы экологиялық білімді қалыптастыруда пәнаралық байланыстарды жүзеге асыру мен оқушылардың сын тұрғысынан ойлау дағдыларын дамыту мүмкіндіктері ұсынылады. Жұмыстың мақсаты – жаратылыстану пәндерін оқыту арқылы оқушыларға экологиялық тәрбие беруді ғылыми-теориялық тұрғыдан

негіздеу және әдістемелер ұсыну. Бұл жұмыста заманауи ғылым мен техниканың дамуына сәйкес әлеуметтік-экономикалық жағдайларды негізге ала отырып, қазіргі мектепте физиканы оқытуда экологиялық зиянсыз технологияны меңгеру қарастырылған. Оқушылардың жеке тұлғасын жан-жақты дамытудың шарты ретінде қазіргі мектеп үшін өзекті болып табылатын пәнаралық байланыс негізінде жаратылыстану пәндерінде экологиялық білім беру мәселелеріне негізделген оқу конференция жоспары дайындалып, орта мектептің іс-тәжірибесіне енгізілді. Мақала ғалымдарды, әдіскерлерді, сонымен қатар қазіргі қоғамды жаңартуға атсалысатын әрбір адамды қызықтырады.

**Түйін сөздер:** қоршаған орта, экологиялық сауаттылық, интеграция, физика, пәнаралық байланыс

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## **РАЗВИТИЕ ЭКОЛОГИЧЕСКИХ ЗНАНИЙ УЧАЩИХСЯ НА ОСНОВЕ ИНТЕГРАЦИИ УРОКОВ ФИЗИКИ И БИОЛОГИИ**

**Аннотация:** В статье определены научно-педагогические основы экологического образования и воспитания на современном этапе, проведен краткий анализ исследований по экологическому образованию учащихся при изучении курса физики в средней школе. Усиление экологического аспекта и роли курса физики и биологии в раскрытии единства природы и окружающей среды, интерпретация роли физических законов и явлений в окружающей среде имеют решающее значение для молодого поколения, которое в будущем будет подключено к производственной среде. В преподавании физики определяется содержание экологического образования в соответствии с достижениями науки и техники, осуществляется трансформация учебных занятий, повышается экологическое образование и культура учащихся, совершенствуются практические навыки. Рассмотрены новые дидактические основы экологической подготовки учащихся при изучении физики в средней школе и рассмотрены значение межпредметной связи в совершенствовании экологических знаний. Предлагается возможность осуществления межпредметных связей и развития навыков

критического мышления учащихся в формировании экологических знаний посредством интегрированного обучения физике и биологии. Цель работы-научно-теоретическое обоснование и предоставление методик экологического воспитания учащихся через преподавание естественнонаучных дисциплин. В данной работе предусмотрено освоение экологически безвредных технологий в преподавании физики в современной школе, исходя из социально-экономических условий, соответствующих развитию современной науки и техники. На основе межпредметной связи, актуальной для современной школы как условия всестороннего развития личности учащихся, разработан и внедрен в практику средней школы учебный план конференции, основанный на вопросах экологического образования в естественнонаучных дисциплинах. Статья заинтересует ученых, методистов, а также каждого, кто участвует в модернизации современного общества.

**Ключевые слова:** окружающая среда, экологическая грамотность, интеграция, физика, межпредметные связи.

**Introduction.** Today, humanity has studied the secrets of the environment, the interrelationships, the scale of possible environmental consequences, the area of distribution, the damage to the economy, the unfavorable conditions for life on earth, and realized that the fight against it is a big problem.

In the modern world, environmental problems have become one of the most important issues in terms of their social significance, which requires humanity to be smarter and smarter. One of the realities of wisdom is environmental awareness. The reconsideration of the spiritual quality of modern humanity as a result of the impact of environmental conditions is based primarily on the development of their responsibility, wisdom, prudence, compassion, the ability to appreciate and understand each of the riches of the environment (Childibaev, 2014:15)

The issue of environmental education is given in the Law of the Republic of Kazakhstan “On Education” (<https://adilet.zan.kz/kaz/docs/Z070000319>, 2007:8), the Law of the Republic of Kazakhstan on Environmental Protection ([https://kodeksy-kz.com/ekologicheskij\\_kodeks.htm](https://kodeksy-kz.com/ekologicheskij_kodeks.htm), 2021:5) “Concepts of environmental education in higher education and secondary schools” (<https://adilet.zan.kz/kaz/docs/P1900000988>, 2021:4 )

Environmental education is the education, training, self-education of the individual, aimed at the formation of human moral behavior and their duties and responsibilities in relation to the environment, as well as the acquisition of special knowledge and practical skills in the field of environmental protection



and sustainable use of nature. and a continuous process of development. Environmental education is important knowledge. This allows students to draw conclusions through their research, gain environmental experience, develop skills and habits that can be used throughout their lives to solve environmental problems, focus on a critical and creative understanding of this experience, and stimulate lifelong commitment (Williams et al.,1993:4). In this regard, the purpose of our study is to determine the content of the methods of formation of environmental education and upbringing of schoolchildren.

**Research Material and methods.** On the basis of the address of the president of the Republic of Kazakhstan K. K. Tokayev “Kazakhstan in New conditions: a stage of action”, a number of strategic plans and programs in the spheres of public life, including education, were adopted. The development of Environmental Protection and environmental literacy is a priority for the country and is indicated in the address on the need to pay sufficient attention to environmental education of the younger generation in schools and universities (<https://adilet.zan.kz/kaz/docs/K2000002020>, 2020:2).

Academician of the National Academy of the Republic of Kazakhstan, professor Beisenova A. S. in her concept of environmental education of schoolchildren: “environmental education should be provided with mother’s milk. It expresses its philosophical point of view. In the future, Kazakhstan offers to the general public the structure, methodological and pedagogical foundations of continuous environmental education and upbringing, teaching methods. In this regard, Professor A. B. Bigaliyev, E. Zhamalbekov, M. N. Sarybekov, A. G. Sarmurzina, I. N. Nugmanov, Zh.B.Shildebayev and others. Pedagogical scientists contribute to raising the local character of environmental education and upbringing at the level of civilized countries (Drob et al., 2005:6).

As is well known, the scientific basis for the content of the natural sciences is common ideas about the relationship between humans and their environment, their unity, and the unity of nature. (Whiteman et al.,2012:9). In this regard, integrated teaching of subjects forms in the minds of students an understanding of the unity of the world and considers that man is a conscious component of nature that contributes to it. The study of integrated subjects creates conditions for achieving the possibilities of creating comprehensive approaches to solving global environmental problems facing humanity today, improving the vital practical skills of students (Babalola et al., 2022:7). Mankind, living and dead nature, engineering and technology are the objects of study of natural sciences. Combination plays an important role in science lessons of global, national and regional principles, which form the needs

and interests of the individual, increase the student's personal experience, knowledge about the problems of the place where he is, the ability to apply practical and research activities, motivation to learn (Imashev et al., 2019:45). One of the main worldview ideas considered in natural science disciplines is the idea of the unity of nature. Knowledge of the relationship of natural phenomena with each other forms a geographical, physical, chemical and biological picture of nature, the unity of which is the concept of a natural and scientific picture of the world.

One of the basic ideas of natural science is the unity and development of nature in the environment. The term "environment" was developed in a science class for students. As the class grows, the range of disciplines expands and students become familiar with the geographic, physical, chemical, and biological factors of the environment. Knowledge of the normal norms of geographical and physical factors of the environment (temperature, humidity, pressure, loudness, radioactivity, etc.), as well as their changes as a result of human activity, their excessive fluctuations (increased radioactivity, the environment It should be noted in the content of the study material that a significant increase or decrease in average temperature) can lead to the extinction of terrestrial life as a result of the negative impact on the flow of processes in the biosphere (Rakhmetova et al, 2020: 38).

Based on my academic experience, my analysis of the pedagogical and methodological literature on the issue of environmental education for students shows that conferences and classes occupy a special place in environmental education. It was found that such lessons help students deepen and deepen their knowledge of the environment, increase their activities in the learning process, and help them master the environmental teaching materials quickly. During the conference and preparation of the conference, students will use supervised and established literature. In our methodology for the formation of environmental education and upbringing of students based on the integration of biology lessons with physics lessons, we used different sources of information:

- Textbooks of biology and physics, scientific literature, electronic textbooks from Internet sources, scientific journals, reference books;
- Various visual aids and didactic materials: presentations, diagrams, models, videos, pictures, logic tasks, etc.

The effectiveness of the conference lessons developed by us in the process of teaching physics in secondary school was proved by a pedagogical experiment. The pedagogical experiment was conducted for the following purposes:

To demonstrate the need to introduce new didactic approaches with

the determination of the level of environmental knowledge of students, to determine the basis for the development of an environmental direction in the learning process and to assess their impact on the formation of knowledge and educational elements of students in qualitative and quantitative terms, to test the proposed educational, methodological and educational system experimentally.

To achieve this goal, the following tasks were set:

- Conducting organizational work in accordance with the stages of the pedagogical experiment (determinative, experimental, control) in the direction of the development of environmental education and upbringing.

- Development of educational materials of ecological content of pedagogical experiment and determination of ways to implement them.

- Identify control and experimental classes in accordance with the requirements of the pedagogical experiment and provide students with the necessary didactic materials.

- Application of innovative methods and new technological approaches (electronic textbooks, models, multimedia, interactive methods, etc.) in the conducted experiment to improve environmental education and upbringing;

- Analysis and generalization of the results of pedagogical experiments.

As mentioned above, the pedagogical experiment consisted of three stages (determinative, experimental, control). The results of the pedagogical experiment were tested on the basis of an elementary analysis of students' responses. The coefficient of assimilation of educational elements was determined by the formula:

$$k = \frac{n}{N} \cdot 100\%$$

here  $n$  is the number of correct answers, and  $N$  is the number of answers to a given question.

**Discussion and results.** In the case of effective organization of the conference, the selected environmental materials can be fully used (Alemu, 2020:4). Although there are many applied aspects of ecology (human ecology, chemical ecology, landscape ecology, industrial ecology, social ecology, ecology of plants, animals, microorganisms, etc.), all areas of modern ecology - the relationship with living organisms and habitats - are fundamentally biological. In addition to the biological sciences, modern ecology is closely related to the natural sciences, such as chemistry, mathematics, physics, geography, and philosophy, history, law, political science, and cultural studies.

One such lesson is the Integrated Conference Lesson on "Electrostatic Properties of Plastics" in Physics, Biology and Chemistry.

1. Lesson Topic: Electrostatic Properties of Plastics.

Educational Purpose: To improve students' environmental knowledge. It trains students to prepare independently with additional scientific literature and promotes diligence and organization. Guidance Type: Conference  
Guidance Lesson plan: I. Basic concepts of electrification of the body, repetition of the law II. Student report on the application of electrification phenomena in technology: A) Types of polymer synthetic materials B) Effects of electrostatic fields on the human body B) Protection against harmful effects of electrostatic fields III. Video "Electrostatic charging" demonstration To illustrate the electrification of one student, let's say that rubbing a synthetic material causes it to become electrified. Synthetic fibers, computer structural details, etc. Because it is made of polymer material, it will be charged when rubbed. Since the gas injector is made of polymer, it is also energized. To explain the different electrical properties of synthetic materials, fluoroplastics such as polyolefins, polystyrene, and polyvinyl chloride are said to accumulate a lot of charge. Student 2 To get the student's attention and interest, ask, "Have you ever seen a belt made of polymer material on an agricultural machine?" They've seen such belts, but they don't realize that the belt develops an electrical charge as it rotates along the pulleys. You should explain to your students that such belts are used on agricultural machinery to load bales of grain, cotton, and hay. However, these belts are made to a certain standard, so they can save a lot of power and prevent fires. In addition, the plastic and the surface of the plastic body accumulate an electric charge and attract dust. Harmful compounds are released into the human body from highly charged substances. Combined with dust, it enters the human body through the atmosphere and degrades physiological conditions (Tuakbaev, 2011:9). Tell students that the negative effects of static electricity on the human body have been scientifically studied. Research has proven the following facts: Electric shocks can lead to depression and headaches. Pain in the heart and repeated strokes irritate the human nerves. Working with electrified materials has strong negative effects on the central nervous system and cardiovascular system. Blood pressure rises. Fundamentally, biological mechanisms adversely affect protein conformational processes. The digestive process is disturbed. The effect of electrostatic fields reduces the ohmic resistance of human skin. Weaken the muscles of the limbs. It has been proven that nerves are less responsive to light and sound, impairing their function.

The effects of the electric field around the high-voltage power line on the human body are the same as those described above. Therefore, we strongly warn students not to play or walk under a pole with a high-voltage line, and

parents are strictly forbidden to plant crops, raise livestock, collect hay, and build a metal garage.

Student 3 We ask students whether it is possible to neutralize the electrostatic field that appears on the surface of synthetic materials with such a harmful effect? We explain this request as follows.

Reduces the electrical resistance of the above materials so as not to accumulate too much electric charge on the surface. For example, the maximum resistance of a fabric made of synthetic polymer material used as clothing should not exceed Ohms. This is a very bad fabric. If we reduce its electrical resistance in ohms, it is a very high quality good fabric. There is a rattling sound when removing clothes made of the above materials (nylon, prolon, etc.). We explain that this is an accumulated electric charge created by friction. Polyethylene with high conductivity antistatic plastics are used as containers for storing quickly evaporating petroleum products, and polyvinyl chloride linoleum is used on the floors of houses where electronic computing centers are located in medicine. We also note that such antistatic materials are used in medicine to make anesthesia masks, rest bags and connecting tubes. Because during friction, the electric field does not accumulate in antistatic materials. If such materials are used in electrical measuring instruments, the accuracy of their display increases, and if they are used in radio engineering, we explain to students why they reduce harmful noise.

IV. Summing up the lesson results. The organization of integrated classes with the interconnection of Natural Science subjects creates a wide range of opportunities for teachers to reveal students' interest and enthusiasm for the subject (Negar et al., 2017:8). As the results of the study showed, the most interested students were to conduct integrated classes with the combination of physics and biology.

Experimental training was conducted in secondary schools № 27, № 42 and № 36 named after M.B. Iksanov in Uralsk, West Kazakhstan region and in secondary schools № 13, № 2, №27, № 28 in Atyrau.

During the determinative experiment, the initial level of knowledge of students was determined by conducting tasks and tests of environmental content.

Figure 1 shows the level of basic environmental knowledge of students in the section "Electrodynamics":

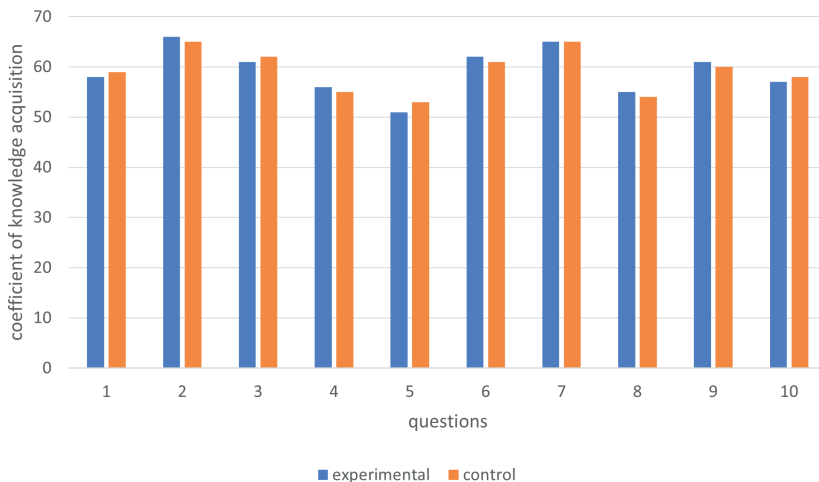


Figure 1. Levels of ecological knowledge of students before the experimental work.

To determine the degree of formation of basic environmental knowledge and concepts of students, level tasks were given and the results were determined (Fig. 2).

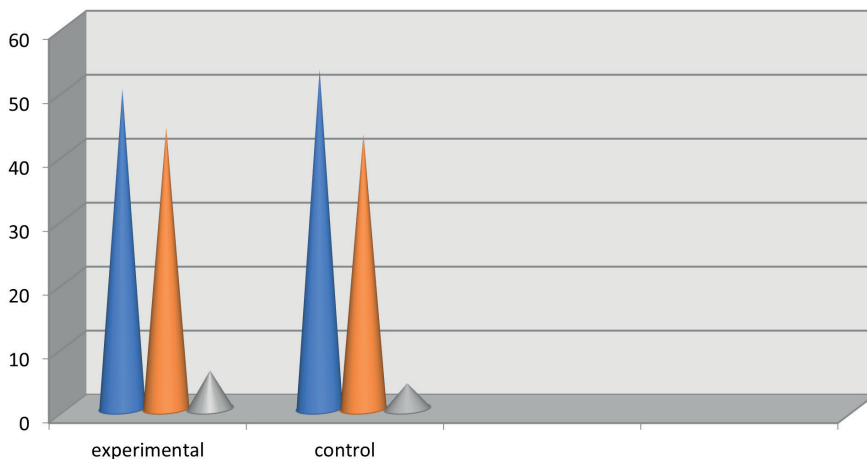


Figure 2. Levels of ecological knowledge of students before the experimental work.

According to the detection experiment, the average educational indicators of the experimental class were shown at the level: lower – 50%, average – 44%, upper - 6%, and in the control class: lower – 53%, average - 43%, upper - 4%.

This showed that their initial levels of education were similar. Based on these results, the following conclusions were made: the course of molecular physics and thermodynamics and the consequences of natural phenomena and their scientific interpretation are insufficient, students' environmental education does not meet the requirements of scientific and technological progress, environmental skills are not formed in accordance with modern requirements. The detection experiment helped to eliminate these shortcomings. On the basis of this, after the completion of the educational material, it was noted that in the process of teaching natural sciences in secondary schools, elements of environmental education and upbringing are not fully realized in all cases.

During the experimental training, the tasks of testing environmental knowledge and concepts were carried out in the following areas:

- Consideration of environmental problems encountered in modern production and economy related to the main directions of scientific and technological progress.

- Familiarization of students with environmental phenomena and concepts, laws of modern technology.

- Explain the principle of construction and operation of technical and technological devices.

The results were processed by comparing the levels of environmental knowledge of students in experimental and control classes. Definition of levels of environmental knowledge and understanding is defined in three directions: low, medium and high.

New methods were used to test the proposed methodological system in the experimental class. Experimental classes were given tasks and teaching materials of ecological content selected in the section "Electrodynamics", and lessons of ecological content were conducted. Section "Electrodynamics" "Electric charges. Elemental analysis of the results of experimental training in improving environmental education and training on "Electrification of bodies", "Sources of electricity and electricity consumers", "Electric current in different environments", "The effect of magnetic waves on the environment" Among these topics, the topic "Electricity in different environments" was considered as an example and the results of the development of experimental material on this topic to determine the level of improvement of environmental education and upbringing are given.

Table 1. Elemental analysis of the improvement of environmental education on the topic “Electricity in different environments”.

Tested element of education and upbringing	The number of correct answers by class, %	
	experimental	control
1	2	3
- Environmental interpretation of the movement of electrons in metals and the nature of the electric field in a conductor	77	63
- The impact of energy on the environment during the transportation of electricity	75	60
- Values and limits of use of semiconductor devices in everyday life	72	58
- The process of ionization in the air and the principle of operation of the electric filter	71	55
- The occurrence of high-voltage voltage in nature and the harm of Corona discharges in nature	70	56
- Environmental problems of electrolysis phenomena	78	61
- Environmental impact of electric current in gases on life	72	54
- The main tasks of environmental education in explaining the topic of electric current in different environments	79	63

From the control works, students ‘ knowledge of the main tasks of environmental education in explaining the topic of electric current in various environments (79%), environmental problems of electrolysis phenomena (78%) was satisfactory. He was able to explain the movement of electrons in metals from an ecological point of view and explain the nature of the electric field in the conductor - 77%, the impact of energy on the environment during the transport of electricity-75%. The values and boundaries of the use of semiconductor devices in everyday life, as well as the environmental impact of electric current in gases on life were described by 72%, the indicators of the process of ionization in the air and the principle of operation of the electric filter (71%), the occurrence of high voltage in nature and the harm of Corona discharges in nature (70%) were lower. The analysis of the quality of assimilation of such environmental knowledge was also carried out on other topics listed above. The level of knowledge of students was determined by level tasks. For this purpose, environmental tasks for 3 levels consisting of 7 questions were given.

Figure 3 shows the level of knowledge of students on the level tasks in the experimental and control classes.



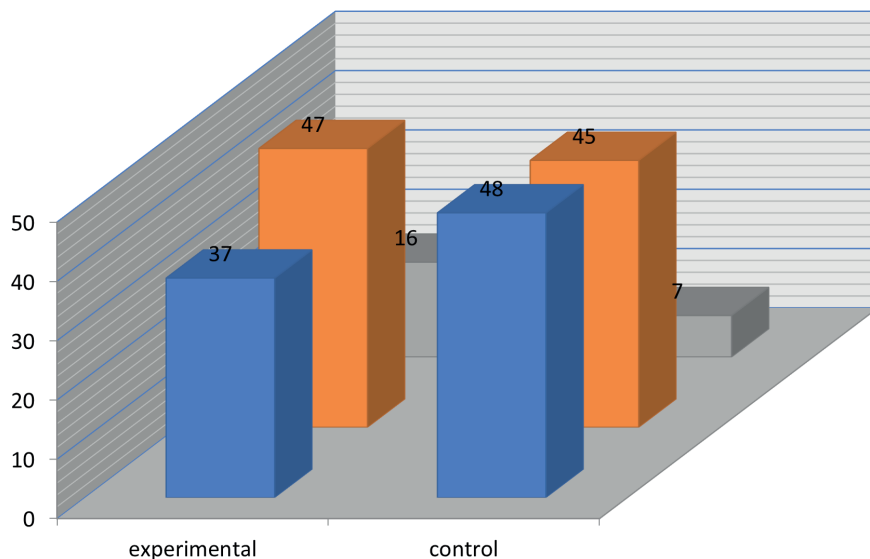


Figure 3. Experimental learning outcomes, reflecting the level of environmental knowledge of students.

The results of the experimental study showed that when using the proposed didactic system, the level of environmental education in the experimental class increased by an average of about 17%, i.e the scientific hypothesis was confirmed by the results of the experimental study.

In the process of teaching physics in secondary school, the content and system of environmental education and upbringing were defined, and a model of a new educational and methodological system of environmental education and upbringing in physics in modern production conditions was developed. In the process of teaching the physical basics of the main directions of scientific and technological progress, a methodological package on improving the environmental education and upbringing of students was developed and the results of the pedagogical experiment were presented.

**Conclusion.** Such interdisciplinary communication is very beneficial for students. Students understand the use of plastics in different sectors of the economy and it requires not only knowledge of one subject, It includes not only physical properties, but also chemical and biological properties. Such education provides students with a lot of environmental information. Help students fully understand the laws of static electricity and draw their own scientific conclusions. This area of electrostatics is studied in conjunction with organic chemistry and biology from grade 11 onwards. Physics research relies on student knowledge the geography of the location of water resources

and mineral fuels, considering the efficient use of natural resources in the study of electricity generation. From chemistry we use the knowledge of the composition of air from human physiology, the harmful effects of various gases on the human and animal body, from biology the significance of the general phenomenon of photosynthesis in human and animal life, environment and man, anthropogenic factors of the environment.

In addition, the organization of integrated lessons in physics and biology in various forms for the formation of environmental education and upbringing:

- Improves students' ability to think critically and logically, stimulates students and has a positive effect on the process of learning new material;
- Develops the ability to master the material from simple to complex, mastering the skills of environmental protection and rational use;
- Facilitates the systematic planning of extracurricular and extracurricular activities with students, the emergence of a number of universal learning processes.

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