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BENEFITS OF IMPROVED TEACHING METHODOLOGY FOR TEACHING NUCLEAR PHYSICS SECTIONS IN UNIVERSITIES BASED ON INNOVATIVE TECHNOLOGIES

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Abstract:

This paper proposes an improved methodology for teaching nuclear physics sections using computer technology, based on modern scientific achievements and innovative technologies. The results of experimental work presented in the article show that the use of innovative technologies in the form of visual demonstration tools effectively form the modern scientific worldview of students. Also, based on an analysis of the advantages and disadvantages of all types of energy sources, an analytical table was proposed that clearly shows the priority of modern nuclear energy sources and their high level of safety.

Keywords: Modern technological devices, mass and energy, computer technology, innovative technologies, electronic program, textbook, animation, slides, nuclear processes, reactions, radiation, nuclear fission, neutrons, radionuclide hazard, environmental sustainability, nuclear reactors, energy sources, sustainable energy supply, analytical table, energy of the future, experimental verification.

It is known that the study of nuclear physics plays a very important role in shaping students' scientific worldviews and acquiring a modern understanding of the structure of matter. It is also believed that the topics of nuclear physics in the section of quantum physics are of particular importance, and the process of studying them requires the use of complex visual equipment and the ability to abstract to a certain extent.

An analysis of the currently available educational and methodological literature on nuclear physics shows that the availability of materials on certain topics offered in this field of physics is not enough for students to acquire new basic knowledge. Based on a detailed study of the contents of the paragraphs of educational materials on topics such as nuclear models, nuclear reactions, nuclear reactors and nuclear power, the following conclusions can be drawn. Not enough hours are devoted to topics in nuclear physics, some information is already outdated and not updated with new knowledge and concepts, the educational material is explained by outdated facts, and most importantly, the lack of practical demonstration materials, active laboratory and practical work leads to the fact that the knowledge and skills of students not formed properly [1]. Also, the lack of the possibility of conducting direct experiments and observations, or their complexity, a large amount of educational material on the topic, all this makes it difficult to understand the very essence of nuclear processes. As a result, we see that this situation in education can lead to the fact that the new generation will not be able to scientifically assess and form an adequate attitude towards the development of nuclear energy, types of nuclear reactions, a new generation of nuclear power plants, their degree of safety, directly related to the development society.

The "Concept for creating a system of continuous education based on innovative technologies" of the Republic of Uzbekistan [2] notes the importance of creating a national education system that can compete on a global scale, improving textbooks and teaching aids based on modern requirements, creating their new generation, optimizing curricula and educational standards. At the same time, the content of currently studied educational topics lags far behind the content of the principles of operation of modern devices operating in real life.

Especially in the teaching of nuclear physics, the lack of information about the new generation of nuclear power plants, and although it is explained that the conversion of a mass defect into energy on the basis of mass energy equivalence in nuclear fission reactions is considered a source of nuclear energy, but the fact that the conversion of energy into mass, having of fundamental importance for understanding the universe, i.e. the formation of gravitational mass due to energy as a result of the collision of high-energy protons in a large collider is not included in the

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educational process, it cannot give a modern idea about them. In addition, ideas about the scale of radiation exposure in the development of nuclear energy in the world and the dynamics of changes in its role in the environment are not included. Eliminating the above shortcomings by improving the methods of teaching nuclear physics using didactic tools aimed at developing and teaching students using innovative technologies and computer tools is one of the urgent problems of modern education.

When teaching nuclear physics, the explanation of nuclear models and various nuclear processes is carried out by traditional methods, and currently not enough attention is paid to methods using new innovative computer technologies.

In particular, there are practically no works using ICTs devoted to teaching topics related to modern achievements in science. In this regard, raising the quality of knowledge in nuclear physics to a higher level and eliminating the gap between the need to form a modern vision of nuclear processes and insufficient knowledge of the methods of teaching nuclear physics based on innovative information technologies is one of the problems of teaching nuclear physics.

Main part. The resources of educational information technologies provide ample opportunities for modeling and animated images of the processes under study, the creative development of the mental abilities of students, the visual presentation of educational information, laboratory work in the conditions of computer experiments and, most importantly, the formation of interest in learning by imitating the display of the real situation on the monitor [3].

In order to improve the methods of teaching sections of nuclear physics using the above opportunities, it is first necessary to ensure that the content of educational materials complies with the state educational standard and the achievements of scientific and technological progress, to ensure the connection between theory and practice by indicating the main areas of practical application of theoretical knowledge when choosing the educational content of nuclear physics, take into account its environmental aspects, and justify the physical nature of each concept, such as a physical phenomenon, physical quantity, model, idea, theory, atomic nucleus, mass defect, binding energy, radioactivity, ionizing radiation, which must comply with fundamental laws and ensure them scientific character.

The modular structure of the content of educational material in nuclear physics, logically interconnected, can be chosen as follows. Atomic nucleus - nuclear changes - nuclear energy - the impact of ionizing rays on a living organism. When studying the theory of the atomic nucleus, it becomes necessary to use nuclear models to express the properties of the nucleus, which include two interrelated reactions - nuclear structure reactions and nuclear fission reactions. At the same time, the use and selection of the necessary model that characterizes the individual properties of the nucleus, or gives an understanding of a particular process, demonstrating the limits and possibilities of using each model directly with the help of computer programs, allows you to expand existing educational information about the properties and structure of the nucleus, and obtain information about that a universal model of the nucleus has not yet been created.

We believe that educational materials need to provide information not only about the above nuclear phenomena and concepts, as well as modern nuclear power plants, but also need to enrich them with topics about theory and experiments proving that energy can be converted into mass. Teaching these topics on the basis of various innovative educational technologies plays an important role in expanding the scientific horizons of students [4].

It should be noted that if the study of such a quantity of information in the traditional way takes a lot of time, then the use of ICT not only saves time, but also facilitates the perception of the essence of the material by the figurative presentation of information. Also, one of the important issues of nuclear physics is the representation of the process of nuclear fission as a source of energy. Understanding the process of nuclear fission and the self-healing of fission reactions through the creation of mathematical models of the increase in neutrons and the probabilities of the development and extinction of nuclear reactions will also form a complete picture of the nature of the control of nuclear reactions. Another central issue is to give students a realistic idea of the physics behind nuclear power and the dangers of radiation.

It should be noted here that each country, in accordance with its natural location, studying which type of energy source has favorable conditions for its creation by analyzing its strengths and weaknesses, in order to achieve a stable and sufficient energy supply, determines which types of sources energy have a priority direction in the economic and social development of the region.

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To this end, we analyzed the advantages and disadvantages of all types of energy sources given in the relevant literature, and proposed a table that allows us to compare them with the characteristics of nuclear power. This table will allow students to assess the role of nuclear power in the social life of people [5].

Table 1. Important characteristics of nuclear and other types of green energy sources in social and economic life.

№	Energy resource	Stable collateral	By reserve long-term	Ecological cleanliness	Enough power	Occupied area	Security level	Convenience in construction	Possibility of mobility	Efficiency	Degree of possibility of long-term work
1	Nuclear power	⫫	⫫	∇	⫫	—	⫫	□	⫫	⫫	⫫
2	Small hydro stations	∇	⫫	⫫	□	Δ	⫫	⫫	—	□	⫫
3	Large hydro stations	⫫	⫫	∇	⫫	⫫	Δ	□	—	□	⫫
4	Solar energy	Δ	⫫	⫫	—	—	⫫	⫫	⫫	—	□
5	Wind energy	Δ	⫫	⫫	—	—	⫫	⫫	⫫	—	□
6	Geothermal sources of thermal energy	□	—	⫫	—	—	⫫	⫫	—	—	□
7	Bioenergy Devices	—	—	⫫	—	—	⫫	⫫	—	—	—
8	Surface Current Power Plants of the Oceans	—	⫫	⫫	—	⫫	—	⫫	—	—	⫫
9	Wave power plants	—	⫫	⫫	—	⫫	⫫	⫫	—	—	Δ
10	Energy from recycling	—	—	⫫	—	—	⫫	⫫	—	—	—

Designations: "⫫" - high; "∇" above average; "□" - medium;
"Δ" is below average; "—" short.

Table 1 shows that nuclear, hydro, wind and solar energy sources, compared with others, have an advantage in such important indicators of energy supply as stability, long-term, the ability to provide sufficient power, and environmental safety.

Depletion of fuel energy sources, all the harm they cause to the environment and human health due to climate change, comparing the safety of modern advanced nuclear power plants, as well as analyzing the possibilities of green energy, it is necessary to show students that nuclear power plants are one of the safest and most important sources energy in the conditions of the Republic of Uzbekistan, all this will largely help to form modern ideas about the convenience and reliability of using modern nuclear energy sources. At the same time, the training of domestic specialists in the field of nuclear energy in the leading universities of Russia also strengthens this confidence.

As noted above, the use of various existing modern computer programs, such as: "TechSmith Camtasia", "MXSAFlash", "ActivePresenter", "EasyQuizzy", "AutoPlay MediaStudio", as well as the use of electronic textbooks developed by us shown in

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Fig. 1: "Nuclear Reactions" [7], "Nuclear Energy" [8], "Modern Nuclear Reactors and Mechanisms of Their Operation" effectively contribute to the study of a new generation of nuclear energy devices, created with the help of nanotechnology and taking into account the results of scientific achievements. At the same time, the organization of the effective use of the possibilities of demonstration presentations with the help of various computer programs, especially those that allow you to observe the dynamics of nuclear reactions and the principle of operation of energy devices and the ability to intervene in the processes occurring in them, leads to the development of the subject with interest.

Fig.1. Electronic textbooks on the sections "Nuclear Reactions" and "Atomic Energy" of the subject "Physics of the Nucleus and Elementary Particles" (certificate № DGU 14456, certificate № DGU 16875).

These electronic programs (see Fig. 1) are created in Delphi, Java, C++, Python programming languages using modern computer capabilities. With the help of these programs, demonstration programs were improved and introduced into the course of Nuclear Physics: animation of the synthesis of thermonuclear reactions, nuclear fission processes, presentation of the work processes of the first, as well as modern nuclear power plants, a table of criteria for assessing their degree of safety, animation of types of nuclear reactors, presentation of fission reactions nucleus, as well as the proton-neutron model of the nucleus. These programs have passed training tests at Namangan State University

Results of experiments and their discussion. Based on the improvement of traditional teaching methods with the help of created electronic textbooks, virtual laboratories, videos and presentations, in order to determine the effectiveness of learning outcomes in nuclear physics and the degree of formation of students' ideas about the laws of physics underlying modern technical developments in this area, initially were determined prerequisites, goals and objectives of the pedagogical experiment, as well as the shortcomings identified in the course of many years of training in nuclear physics are taken into account.

The main purpose of the pedagogical experiment is to identify and solve problems that arise in the formation of the modern scientific worldview of students when teaching them a course in nuclear physics, and to test the effectiveness of an improved teaching methodology for this course based on the use of information technology. Pedagogical experiments took place in three stages, the first stage was the study of teaching methods for the course of nuclear physics, the real state of theoretical and laboratory work of students in the direction of physics of Namangan State University in 2012-2017, on their basis, the need to use information technology to eliminate the identified problems was determined, and improved methodology for teaching a course in nuclear physics.

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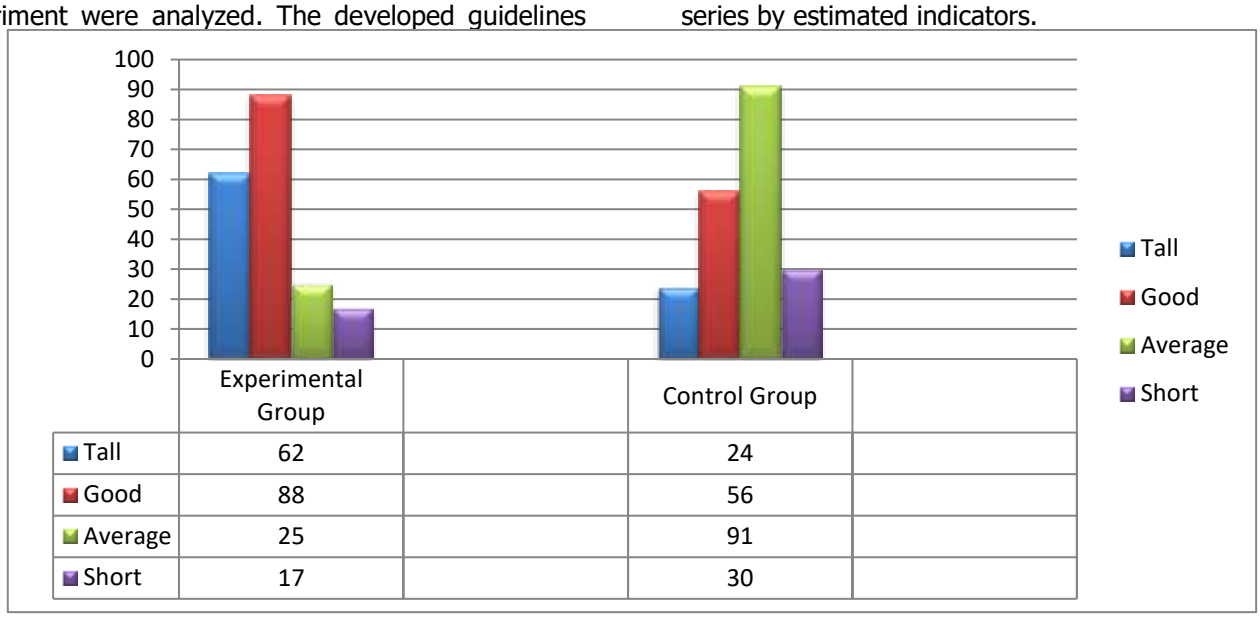
At the second stage (2017-2020), the content of the training materials was studied. As a result, a teaching methodology was proposed that enriches the content of educational topics with the help of information technology. This technique was recommended to teachers of Nuclear Physics of Namangan, Andijan and Ferghana State Universities, where methodological seminars were held and methodological recommendations were given on the use of this technique. Experiments were also conducted to study nuclear physics by students. In 2019-2020, the results of the improved teaching methodology were determined.

At the third stage (2020-2021), control experimental work was carried out. In the experimental and control groups, a course in nuclear physics was taught, and the results of the pedagogical experiment were analyzed. The developed guidelines were statistically processed and introduced into the educational process.

Based on the results of the analysis of the results of the pedagogical experiment, it was found that the knowledge, skills and abilities of the students of the experimental group involved in the research process are effective compared to the students of the control group. For an objective assessment of this statement, a statistical analysis was carried out, where the Student and Pearson methods were chosen. This method has the ability to determine and objectively evaluate the indicators recorded in the two groups. According to the essence of the mathematical statistical method, at the initial stage, the statistical indicators recorded in the experimental and control groups were determined as samples, and the diagram shown in Figure 2 was built by creating variational series by estimated indicators.



	Experimental Group		Control Group	
Tall	62		24	
Good	88		56	
Average	25		91	
Short	17		30	

Fig.2. The final diagram of the pedagogical experiment on improving the methods of teaching sections of nuclear physics in universities based on innovative technologies

It can be seen from the diagram that the high and average scores in the experimental group are higher than in the control group.

The results of pedagogical experiments show that the method of teaching nuclear physics is effective, as it is noted that the quality of education has increased by 38%. As a criterion for the effectiveness of the teaching methodology, such cases as consistency, systematicity, precise justification of answers, meaningfulness, and completeness of knowledge were identified.

CONCLUSION.

- With the help of programs created on the basis of information technologies: "TechSmith Camtasia", "MXSAFlash", "ActivePresenter", "EasyQuizzy" and "AutoPlay MediaStudio", and additional electronic textbooks developed by us: "Nuclear Reactions", "Atomic Energy", "Modern Nuclear Reactors and Mechanisms of Their Operation", the existing methods of teaching nuclear physics were improved, combining all the achievements of modern science.
- A table has been created to compare the important characteristics of nuclear and other types of

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energy sources in social and economic life. The analysis of this table will help students evaluate the possibilities of energy sources and understand the need to use green and nuclear energy instead of fossil fuel sources that are harmful to the environment and human health. This table can be used to analyze and select your own energy in any country.

- The content of educational materials is at the center of the methodology of teaching nuclear physics based on computer technology, and the teacher is the organizer of the students' learning activities, and the computer performs the function of using information technology.
- The results of experimental work have shown that the enrichment of the content of educational materials of sections of nuclear physics with the achievements of scientific and technological progress, and their teaching in a visual presentation form, leads to an increase in the level of knowledge of students and the activation of the educational process.

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