ІІ. ПРОБЛЕМИ МЕТОДИКИ НАВЧАННЯ ФІЗИКИ

USE OF ICT IN THE STUDY OF NUCLEAR PHYSICS

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У статті розглянуто окремі аспекти методики фізики, які можуть бути покладені в основу розробки та удосконалення програмних засобів для моделювання фізичних явищ та процесів з розділу «Атомна і ядерна фізика», створення майбутньої віртуальної фізичної лабораторії та вироблення методики її впровадження у навчальний процес середньої школи.

Some aspect of methods of teaching Physics for development and improvement of educational tools for modeling physical phenomena and processes in the course "Atomic and nuclear physics", creation of a future virtual physics laboratory and development of methods for its implementation in an educational process in the secondary school have been examined in the article.

Problem formulation. Information technology plays an ever growing role in the receiving, storage and transfer of knowledge.

The latest educational information tools are nowadays a powerful tool for teaching physics at school, which involve extensive use of computer and special software aimed at improving both the educational process and the personal formation of future highly qualified specialists, forming his active position of the person, whose conscious actions largely influence the level of his professional competence. In these circumctances information technology on the one hand makes search, processing and presentation of the new data easier [1]. On the other hand the current state of information and communications technology (ICT) provides wide opportunities for modeling physical processes [2], which contributes to a better understanding of the nature of physical phenomena and processes and improve learning possibilities and efficiency. Despite the wide range of pedagogical tools for creation of models for physical processes there is a problem of choosing the suitable software [3] and its appropriateness for students of a particular age group.

Analysis of previous studies. Consideration of ICT development and its methodical providing is examined by local researchers as M.Zhaldak, M.Lviv, N.Morse, S.Rakov, Y.Trius, including researchers-physicists S.Velychko, Y.Zharkih, J.Zhuk, V.Zabolotnii, A.Ivanytskiy, A.Leszczynski, I.Salnik, B.Susya, M.Shut and others. The works of these authors focus on the creation of educational software and methods of their application to study different topics, developing appropriate computer-based assessment systems of students' achievements and so on.

However, insufficient attention is paid to the definition of ICT capabilities for modelling physical processes and phenomena. In particular, the software for individual study of students remains insufficiently defined, as well as the choice of programming language for building up the models on quantum physics and the physics of the nucleus, their research and methods of use.

Article objection. The purpose of this article is to study the known issue of methods of teaching physics to create the software for virtual demonstration experiments that will help to clarify the essence of the studied phenomena and strengthen the students' commitment while studying.

Therefore, our task is to investigate the requirements that apply to educational software tools, develop the simulators and virtual labs, ground the principles of problems selection for virtual labs, as well as determine their role in the course "Atomic and nuclear physics" and interpret the results of virtual experiments.

Basic material. Due to the increasing role of ICT in solving various teaching purposes in the educational process there erised the term "information and educational environment" and "information and learning environment". In the well-known dictionary by S.Goncharenko information-educational environment is defined as "a set of conditions, that contribute to the emergence and development of processes of information and educational interaction between students, teachers and the means of new information technologies, as well as the formation of cognitive activity of the student on condition of filling the environment's components ... with substantive content of a particular course" [4, p. 149-150].

Information-educational environment is a software and telecommunications pedagogical space with unified means of the educational process realization, information support and documenting. This approach allows the teacher to move the focus from active teaching to "information-educational environment", where the student is self-learning and self-developing. With such organization of education internal activity mechanisms of the person are invoked in the interaction with the environment. The more and better the person takes advantage of the environment, the more successful is its free and active self-development: a human is both product and creator of its environment, which gives a physical basis for life and enables intellectual, moral, social and spiritual development [6, p. 88].

In this article we will focus on one of the components of the information-educational environment, namely the creation of support for learning process.

In the methodological aspect of teaching the course "Atomic and Nuclear Physics" is very difficult. This is explained as follows: the materials contain a significant number of new concepts and phenomena that do not have their counterparts in the macrocosm; complex functional relationships that take place between the relevant physical quantities, can't be used on the physics lessons; missing equipment (working models, layouts, tools) to implement quality educational experiments in quantum physics in terms of secondary school; educational experiment in quantum physics in secondary school does not disclose quantitative characteristics and laws of the microworld phenomena nor possibilities of their practical use. At the same time ICT enable effective issues solving, simultaneously activating independent learning activities of each student. In these circumstances, we consider that the study of the course "Atomic and Nuclear Physics" takes 15 hours in the 11^{th} form (academic level) and 32 hours (profile level) [7].

As a result of the course student know: nuclear model of the atom, the quantum postulates of Bohr, Pauli principle, the physical basis of nuclear energy, types of radiation, radioactive decay law, the principle of dosimeter, methods of radiation protection, the general characteristics of elementary particles; understand the essence of the emission and absorption of light by atoms, spectral analysis, nuclear and thermonuclear reactions, a chain reaction of uranium fission, radioactivity, quark model of elementary particles; are able to explain the energy states of the atom, atomic and molecular spectra, physical bases of the periodic table of chemical elements, the nature of X-rays, the existence of isotopes, nuclear stability, alpha and beta decay, mass defect, proton-neutron model of the atomic nucleus; can classify elementary particles; know experimental observation methods of substance spectra, research of tracks of charged particles; are able to solve physical problems using quantum postulates of Bohr, the binding energy of the atomic nucleus, the law of radioactive decay, as well as problem on nuclear reactions and nuclear reactor efficiency [7, p. 16].

Studying the course covers compulsory demonstrations as: model of Rutherford experiment; structure and performance of ionizing particles counter; pictures of particle tracks; as well as following laboratory works: monitoring of continuous and line spectra of a substance; research tracks of charged particles from the photos.

There is a physical workshop provided in profile classes, which included two labs on this course:

1. Modeling the radioactive decay.
2. Study of the structure and creation of radiological map.

Undoubtedly, the demonstration experiment should be a major component of the experimental method of physics study at school [1]; usually all the basic physical phenomena and concepts describing them, must be demonstrated. Successful demonstration experiment, displaying the physical phenomenon, conducted during the theoretical presentation, overcomes a formal approach to physics, promotes better theory adoption and assimilation, reveals the inherent laws, builds up all the accumulated experience into a holistic view about the world and expansion of their horizons; thanks to successful demonstrations studying physics becomes more understandable and interesting.

But a real demonstration on atomic physics is rather difficult to conduct because of the health hazard. There are two possible outcomes of this situation for demonstrative study of physics:

1. Investigation of "material models" instead of real objects, considering not the exact phenomenon, but its material counterpart, such as drop model of the nucleus – nucleus structure is examined as a drop of liquid. This is for sure a good alternative for real demonstrations, but the main drawback of "material models" experiment is that not every object of study can be replaced with an equivalent analogue and, most importantly, mechanical models often do not fully convey the properties of the "original", distorting the right properties of the microcosm.

2. Computer modeling (simulation) is used instead of corresponding experiment on atomic physics. Graphical display of modeling results on the computer screen (multimedia board) together with the animation of the phenomenon or process allows students to easily take large amounts of content information. The advantages of virtual labs are obvious, because students obtain impressive visualizations that contribute to the best memorization and comprehension of the material. In addition, you can always change the conditions of virtual experiment and track the changes in the results, drawing students' attention to the fine points of the phenomenon, went unnoticed at first glance, an example of which can serve a virtual laboratory for the study of liquid crystals [2] or other problems [5].

Development of a virtual laboratory work involves computer modeling of physical process flow and development of graphic content of the lab. Process of computer model creating of a physical instrument includes several stages: animation of individual elements of the physical instrument, programming its parameters and characteristics on the flow of the physical process. All the developed instruments are recorded in the instruments library. Thereby the developed tools can be used in new laboratory works, and new required device are created and added to the library. The last stage of the development of laboratory work is a combination of individual components in an overall system in which they work together as a unit.

It should be understood that although computer simulation of physical processes has several advantages for the learning process compared to its real flow, but it can not completely replace real physical experiment, as it considers the ideal case of process, which eliminates the influence of random external factors, which in some cases can significantly affect the operation of the system, distorting the results. That is why the best option for laboratory work organisation is combination of firstly accomplishing the labs in virtual form (to examine the essence of a physical process) with further testing of obtained results in a real experiment (where possible in term of safety), e.g. observations of continuous and line substance spectra. In addition, chance to compare virtual and real experimental data from the same experiment let to draw conclusions about the appropriateness of analogies between the actual processes and their simulation on the one hand, and the effectiveness of pedagogical tool development on the other. Thus, the combination of traditional and virtual experiment is able to give not only professional knowledge, but also form a general culture of personality.

Virtual laboratory workshops are an important didactic means in the study of physics in general and the course "Atomic and Nuclear Physics" in particular, as they contain means of modeling of physical processes, the most effective of which is combination of animation and real visualization of different experiments. This trend is in our opinion quite effective for the further development of methods of teaching physics and especially in terms of clarifying the nature of the microcosm phenomena.

Conclusions. Modern school physical education becomes more innovative, wherein it is necessary to maintain all positive aspects of education, and also to make it meet international standards.

Effective formation of concepts about modern models of the atomic nucleus is impossible without giving specific results of relevant experiments. So the best type of demonstrations and laboratory experiment variations is logical and consistent combination of virtual models in created pedagogical tools and their counterparts in real experiments.

Use of analogy in atomic nucleus modeling requires clear reasoning. To prevent the identification of a model with real object it is necessary to specify application limits of specific analogy in this model.

Perspectives for further research in this area. The next step, in our opinion, is the further development and improvement of software tools for modeling physical phenomena and processes of the course "Atomic and Nuclear Physics," creation of a virtual physics laboratory and production of its implementation methods of in the educational process.

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