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USE OF PEDAGOGICAL TECHNOLOGIES IN TEACHING QUANTUM PHYSICS

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ABSTRACT

The article discusses the scientific and practical foundations for improving the teaching of quantum physics. The main directions and features of improving the teaching of quantum physics in an innovative educational environment are identified.

KEYWORDS: - Future physics teachers, quantum physics, innovation, methodological training, structure, educational process, information technology.

INTRODUCTION

High-quality professional training of future physics teachers presupposes their detailed acquaintance with the modern laws of physics and methods of organizing the educational process. At present, special importance in didactics is given to the use of pedagogical technologies in the organization of the educational process at the university. One of the means of raising students' interest in teaching and educational activities and achieving high cognitive results, both in the classroom and in extracurricular work, is the project activity of students.

THE MAIN RESULTS AND FINDINGS

In accordance with the tasks, the considered project methodology includes three stages: "Challenge - Comprehension - Reflection (reflection)". They are a technological basis, a basic model that allows students to independently determine the goals of learning, the object of study to actively search for scientific information and reflect on what they have learned.

At the stage of challenge, the process of actualization of the existing theoretical knowledge and ideas about quantum physics takes place in the intellectual consciousness of students. Since this combines individual and group forms of work, the participation of students in the educational process is activated, and cognitive interest is formed and improved. The result of these processes is their independent determination of the goal of further educational and research activities.

At the stage of comprehension, students come into direct contact with new scientific information and become carriers of new ideas. It

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is generalized and systematized. The student gets the opportunity to think about the nature of the object being studied, learn to formulate questions as the ratio of already known and new information and develop their own conclusions. It is very important that already at this stage, with the help of a number of techniques, the teacher helps students track the process of their own understanding of new ideas.

The stage of reflection is characterized by the fact that students consolidate new knowledge and actively rebuild their own ideas in order to include new quantum concepts in them. Students' analysis of the development and effectiveness of their own mental operations is the essence of this stage.

In the course of work using this technique, students master various ways of integrating scientific information, learn to develop their own opinions based on understanding various experiences, ideas and perceptions, build inferences and logical chains of evidence, express their thoughts clearly, understandable to others, confidently and correctly in relation to others.

Insufficient attention to the concept of state gives rise to inadequate perception of the regularities at the quantum-physical level by students. The random behavior of micro-objects, its probabilistic description, the statistical nature of the results of measurements over quantum systems in superposition states are the subject of study at the university. Meanwhile, it is precisely these aspects of quantum mechanics, which constitute the foundation of quantum physics, that show a deep fundamental difference between the classical and quantum levels of organization of matter. [4. p. 25].

To implement a consistent description of microparticles in the topic "Elements of Quantum Mechanics", it is proposed to consider the following issues.

1. Corpuscular-wave dualism of the nature of matter and field:

- corpuscular-wave nature of light, dualism of the properties of microparticles;

- electron scattering as an experimental confirmation of the special properties of microparticles;

- the physical meaning of de Broglie waves as functions of quantum states of free particles.

2. The Heisenberg Uncertainty Ratio:

- explanation of the uncertainty relation on the basis of a thought experiment on the scattering of electrons by a slit;

- the physical meaning of the uncertainty relation, the inapplicability of classical concepts to the motion of micro-objects;

- lack of trajectory for microparticles [3. p. 228].

3. Description of the state of the microparticle:

- wave function;

- the probabilistic meaning of the square of the modulus of the wave function;

- some additional information from mathematics to help describe the nature of micro-objects;

- the principle of superposition of states.

4. The dynamic principle in quantum mechanics:

- the peculiarity of the change in quantum states in time;

- construction of a dynamic equation of quantum mechanics (using the method of dimensional analysis).

In quantum mechanics, due to the uncertainty principle, it is impossible to set the state of a particle in the same way as in classical mechanics. Moreover, if the state of a classical particle at each moment of time is set by

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numbers - the values of its coordinates and velocities, then the state of a quantum particle at each moment of time is set by a complex function of its coordinates. This function is called the wave function. The square of its modulus is interpreted as the probability density of detecting a particle in a particular place in space. This reflects one of the main features of microparticles - the fundamentally random nature of their behavior. Most often, speaking of quantum particles, they focus on the factors of chance and probability. In this case, a remarkable property of the behavior of a microparticle remains, as it were, in the shadows: their state (wave function) changes in time according to a dynamic law, which is expressed in the Schrödinger equation [6. p. 78].

To form students' quantum concepts means to familiarize them with the basic properties of the objects of the microworld, the history of their discovery, and research methods.

The use of design technology is always focused on independent research activities of students - individual, pair, group, which they perform for a certain period of time.

Project technology always presupposes the solution of some problem, which provides, on the one hand, the use of various methods, teaching aids, and on the other hand, the integration of knowledge and skills from various fields of science, technology, technology, and creative fields. The results of completed projects should be practical.

The classification of projects is carried out according to various criteria. By the nature of students' activities, practice-oriented, research, informational, creative, role-based and mixed projects are distinguished. By the complexity of the knowledge used, mono- and interdisciplinary projects are distinguished. Classifies projects by the duration of implementation: mini-projects, short-term and long-term, as well as by a number of other characteristics [5. p. 98].

There are a number of types of projects, depending on the criteria chosen. Such classification criteria can be:

- View. By the nature of the subject area, projects are subdivided into investment, research, educational, mixed, etc.

- Scale. According to the size of the project budget, the number of participants, duration, projects are divided into: small, medium, large.

- Duration. According to the duration of the implementation period, projects are divided into: short-term, medium-term and long-term projects.

- Complexity. By the degree of difficulty: simple, complex and very complex, etc.

Work on a project begins with setting goals. It is the goals that are the driving force behind each project, and all the efforts of its participants should be aimed at achieving them. Special efforts should be devoted to the formulation of goals, because the success of the whole business depends on the thoroughness of this part of the work. First, the most general goals of quantum physics are determined, then gradually they are more and more detailed until they descend to the level of the most specific quantum problems facing each participant in the work.

After acquainting students with the theoretical aspects of quantum physics, building the process of teaching students according to the design technology, their independent practical work should be organized to prepare for the application of this technology in the study of quantum physics. For seminars in theoretical physics, students receive an assignment: to take part in project activities. Using the knowledge gained at the lectures on quantum physics, the results of the formation of quantum physics, independently develop information projects on the topics of quantum physics.

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An intensive search for pedagogical technologies that ensure active interaction and the fullest involvement of students in the process of joint educational activities led to the need to use in the educational process the training of future physics teachers using the technology of collective teaching methods.

Collective peer-learning of students is carried out through the inclusion of each student in active research activities to teach others and includes a certain sequence of actions:

- study the proposed material on quantum physics independently (individual student work);

- explain this material to another student and ask a question for understanding what he heard (work in pairs);

- explain this material to the third student, i.e. carry out actions identical to the previous stage of work, and then repeat them with other participants in the educational process (work in pairs of a shift composition);

- in the process of generalizing the material, be ready to manage the educational (group work of students) [2. p. 178].

Thus, the inclusion of students in all the possibilities of the form of educational interaction is ensured, and the potentials of individual, pair, group and collective activities of students are realized.

The conditions for the effective organization of joint work of students in a group in order to ensure a unified process of mastering knowledge in quantum physics and personal development of each participant are as follows:

- a "field" is created for the self-realization of each student, the main meaning is that everyone learns and develops on the basis of reflection, defining their role and position in the process of joint work. "Field" is a range of different types of activities: cognitive, organizational, communicative, etc .;

- self-government functions, i.e. a leader or leaders are allocated, a system of rules is established, types and methods of work are selected and distributed, the measure of everyone's responsibility for completing a task is determined;

- there is a system of humanistic relations, which presupposes relations of mutual respect, benevolence, trust, consent, support, but also opposition, disputes, etc .;

- the process of harmonization of personal and common goals and interests is being carried out. This means that the contradictions that arise between them can be resolved at different times both in favor of personal and in favor of common goals and interests, this is determined by the conditions of a particular situation;

- conditions are created for the manifestation of both the creative qualities of the personality of students and the executive discipline;

- an atmosphere of emotional solidarity, joint emotional chewing of joy, grief, sympathy is established [1. p. 46]

Conclusion

Thus, the use of various methods of teaching in the classroom in theoretical physics allows solving a certain number of problems: modeling pedagogical reality as a professional impact in the context of pedagogical interaction; the formation of the ability to analyze the internal state of a developing personality; development of the ability to creatively solve pedagogical situations that arise in unforeseen circumstances; development of the ability of professional self-regulation; formation of quantum representations, etc.

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