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PLANNING OF PROBLEM-BASED LESSONS AND EXPERIMENTAL SYSTEM IN PHYSICS IN SECONDARY SCHOOLS

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A B S T R A C T	K E Y W O R D S
This article analyzes the methodology for planning and conducting problem-activity lessons in physics and the structure of the experimental system in school physics. The seven stages of a problem-activity lesson - from creating a problem situation through consolidation of new knowledge and reflection - are presented in detail. Four types of school physics experiments are classified: demonstration experiments, frontal laboratory work, physics practical sessions, and extracurricular experiments and observations - with identification of their didactic functions.	Problem-activity lesson, experimental-activity model, demonstration experiment, frontal laboratory work, physics practical session, lesson map, reflection, problem situation, hypothesis.

INTRODUCTION

In the process of teaching physics, there are lessons that are primarily devoted to the formation of knowledge. There are also lessons that develop planned skills along with the formation of knowledge. If the teacher wants to organize active learning based on the ability of students to solve cognitive problems, but does not consider how students can solve the cognitive problem, we call such a lesson problematic. Problem-based lessons are lessons in which the teacher organizes and manages the activity of solving cognitive problems together with students and ensures that students understand the process of solving problems. This term is borrowed from the works of G.P. Shchedrovitsky.

Experiments in the school physics curriculum reflect the teaching of the scientific method of knowledge in physics as a subject. Various experiments allow students to get acquainted with the essence of the experimental method and its role in scientific research, and to instill in them the necessary skills [1].

The history of problem-based learning dates back to the 60s-70s of the 20th century. The theory of problem-based learning, developed in Russia by scientists such as M.I. Makhmutov, I.Y. Lerner, and A.M. Matyushkin, has been widely introduced into modern school practice. In the Uzbek education system, a number of studies have been carried out in recent years on the application of problem-based learning principles to physics lessons.

In terms of lesson organization, teachers distinguish three types: informational lessons, skill-building lessons, and problem-based lessons. Although the first type of lessons predominates in traditional teaching, they do not provide sufficient student activity. Within the framework of the experiential-activity model, problem-based lessons should occupy a central place, since they form not only knowledge in students, but also thinking and problem-solving skills.

Literature review

A.I. Bugaev writes that the presentation of the physics course in high school should be based on experiments. This is because the main stages of the formation of concepts - observing a phenomenon, establishing its connections with other phenomena and introducing quantities that characterize it - cannot be effective without the use of physical experiments. "In order to give students deep and solid knowledge and develop important practical skills and abilities in them, it is necessary to coordinate the use of various educational experiments" [3, p. 154].

He classifies the existing system of school physics experiments according to organizational criteria: 1) compliance with the content of the physics curriculum; 2) the main form of teaching - lessons; 3) specific material resources of the school. This classification fully takes into account the activities of the teacher and students. In this case, the experimental system consists of four types: 1) demonstration experiments; 2) frontal laboratory work; 3) practice in physics; 4) extracurricular experiments and observations.

A.I. Bugaev justifies the importance of experiment in physics education as follows: the main stages of the formation of concepts - observing a phenomenon, establishing its connections with other phenomena and introducing quantities that characterize it - cannot be carried out without the use of physical experiments. Great physicists - Galileo, Faraday, Oersted - also made their discoveries directly through experiment. Therefore, instilling experimental skills in students is one of the main tasks of physics education.

Y.A. Saurov studies school physics experiments in a broader classification: qualitative experiments (observing phenomena), quantitative experiments (establishing relationships between quantities), research tasks (determining nominal quantities) and creative tasks (designing devices). This classification allows the teacher to use various experiments in a balanced way throughout the school year.

Research Methodology

The study analyzed scientific sources on the theory of problem-based learning and the experimental-activity approach. Observations and pedagogical experiments were conducted in schools in the city of Tomsk. The method of planning problem-based lessons was developed based on the principles of problem-based learning and taking into account the experience of research work in schools. A lesson map system was created and reflective methods for assessing students' skills were tested.

Frontal laboratory work is performed by all students in the class using the same equipment under the supervision of a teacher. In the upper grades, physics practice is conducted, which completes the physics course in each class. Practical work is quite complex, therefore it is performed in small groups (2-3) according to a detailed description. Many works allow students to directly test the theoretical principles learned.

2 experimental classes and 2 control classes (total 144 students) participated in our study in schools in Tomsk and Shakhrisabz. In the experimental classes, problem-based lessons accounted for 65% of the weekly physics lessons. Diagnostic observation was conducted every two quarters during the academic year and skill levels were assessed.

At the stage of designing problem-based lessons, the teacher first clearly defines the goal of the lesson: what new knowledge will be formed, what skills will be developed. Then a problem situation is selected that is appropriate for this goal. When the problem situation is presented in a real-life context - for example, Why does an iron bridge expand in the heat? - students' motivation is much higher.

Analysis and results

Planning a problem-based lesson is determined by its construction stages. Stage 1: creating a problem situation that demonstrates students' knowledge gaps on a particular issue. The teacher demonstrates the experiment, students perform experiments and then discuss the essence of the experiment based on theoretical knowledge of physics. As a result of difficulties in explaining the facts identified in practice, students form an emotional attitude to the material. Stage 2: formulating a problem that needs to be solved in the lesson to obtain new knowledge. Stage 3: individual students create hypotheses to solve the problem. Stage 4: discussing with students the appropriate hypothesis to solve the problem, jointly clarifying why this hypothesis is suitable. Stage 5: solving the problem based on new knowledge. This is mainly done by the teacher, who shows how the students' problem arose in science and how it was solved. Stage 6: consolidating new knowledge in the form of a formula or mathematical notation. Step 7: Evaluation of interactions in the process of solving problems is an important aspect of learning. Evaluation is carried out by the teacher through observation or special cards, or during the discussion of students' joint work and filling out reflection cards.

Our observations showed that in the classes of teachers who systematically conducted problem-based lessons, the level of knowledge of students during the academic year was 23-27 percent higher. The activity index in the lesson increased by 1.8 times compared to traditional classes. These results quantitatively confirm the effectiveness of problem-based lessons.

When conducting demonstration experiments, the teacher must adhere to a number of methodological requirements. Ensuring the visibility of the experiment - all students should like the experiment. The experiment should be tested in advance, an experiment with unexpected results in the lesson creates a misconception among students. The teacher should activate the students' observation through questions and answers during the experiment.

To increase the effectiveness of frontal laboratory work, the correct distribution of tasks within the group is important. Usually in a group of 3-4 people: one student performs the experiment, the second observes and records the results of the experiment, the third fills in the table, the fourth writes a conclusion. Over time, the roles of the students should alternate so that each student masters all the skills.

It is necessary to plan the physics practice in detail: in the first lesson, students plan and prepare, in the second and third lessons they carry out the main experiment, and in the fourth lesson they formalize and present the results. This structure allows students to go through the scientific research process from the very beginning.

Extracurricular experiments and observations teach students to find the laws of physics in everyday life. For example, tasks such as Observe the refrigerator compressor and heat transfer process or Record the temperature change in a house for 24 hours will interest students and develop their physical observation.

In order to organize the system of experiments in a complete and integrated manner, the teacher should draw up a plan for all experiments at the beginning of the year. This plan should specify which type of experiment will be used for each topic. Such a plan will allow the teacher to prepare the necessary equipment in advance and ensure a balance between experiments during the academic year.

Demonstration experiments form the correct initial concepts about new physical phenomena and processes, reveal patterns, introduce research methods, and demonstrate the structure and principles of operation of some new devices and equipment. Demonstration experiments play an important role in developing students' solid knowledge, observation skills, analysis and conclusion skills.

Currently, in accordance with changes in the content of physics education, the principles of building a new system of experiments in school physics have been developed. I.P. Borisova, a member of the Federal Expert Council on Educational Technology of the Ministry of Education of the Russian Federation, noted that in accordance with the new requirements, experience, while remaining a means of developing demonstrative and practical skills, is becoming an object of study within the structure of scientific methods of knowledge.

Conclusion/Recommendations

The organization of problem-based lessons and the full implementation of the system of experiments significantly activates the cognitive activity of students. The seven-stage structure of the problem-based lesson gives the teacher a clear direction in planning and conducting the lesson, encourages students to actively participate in each stage. The constant use of reflection cards ensures that students understand their own learning process.

Each of the four types of experimental systems in school physics performs a separate didactic function in its place. Therefore, we recommend planning them as a complementary system: demonstration experiments - at the stage of knowledge; frontal laboratory work - at the stage of skills formation; practice - at the stage of consolidation and deepening; extracurricular experiments - at the stage of developing independence and creative thinking. This systematic approach serves to develop students' scientific cognitive skills in physics education.

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