

THE ROLE OF EXPERIMENTS IN TEACHING PHYSICS (GRADES 7-9) AND THE METHODOLOGY FOR THEIR EFFECTIVE ORGANIZATION

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Abstract

This article covers the methodological foundations of organizing and conducting experiments in the 7th-9th grade physics course. The role of experiments in strengthening students' theoretical knowledge, developing practical skills, and forming scientific thinking and observation is analyzed. The stages of conducting the experiments – preparation, execution, analysis of results, and the process of drawing conclusions – are consistently described. It also reveals the significance of demonstration experiments, laboratory work, home experiments, and virtual laboratories in the educational process. The role of home experiments in developing students' independent thinking, creative approach, and research skills is substantiated. The article presents methods for organizing simple and safe experiments in various physical disciplines (pressure, Archimedean force, surface tension, friction, center of gravity). As a result, the experimental activity was effectively carried out

Keywords

physics education, experiment, laboratory work, home experiments, methodology, scientific thinking, observation, practical skills, physics lessons, educational process, pressure, Archimedes' force, surface tension, friction, center of gravity, virtual laboratory, educational technologies

Introduction

Improving the process of teaching natural sciences, particularly physics, is considered one of the important tasks in the modern education system. Physics plays a special role in shaping students' scientific worldview not only as a complex of theoretical knowledge but also as a science focused on the empirical study of natural phenomena. From this perspective, establishing experimental activities in the effective organization of physics education in grades 7-9 of general secondary schools remains one of the most pressing issues.

Currently, innovative approaches aimed at increasing student activity, developing independent thinking, and harmonizing theoretical knowledge with practice are being widely implemented in the educational process. In particular, the use of experiments in teaching physics serves to deepen students' understanding of the subject, their perception of physical laws through direct observation, and the development of practical skills. Through experiments, students not only acquire ready-made knowledge but also learn to independently search for, analyze, and draw conclusions.

In terms of age characteristics, students in grades 7-9 are observant, curious, and inclined toward practical activity. Therefore, the correct organization of physics experiments at this stage is an important factor in increasing their motivation to acquire knowledge. However, in practice, there are a number of methodological problems related to the effective organization of experiments, their purposeful integration into the lesson process, and the establishment of students' independent experimental activities.

The relevance of this article is determined precisely by these aspects. It aims to analyze the scientific and methodological foundations of organizing and conducting experimental activities in the physics education process in grades 7-9, highlight the types of experiments and methods for their application, and identify ways to develop students' skills in conducting independent experiments.

The object of the research is the process of teaching physics in general secondary schools, and the subject is the methodology of organizing experimental activities in grades 7-9. The research results serve to increase the effectiveness of physics lessons, develop students' scientific thinking, and ensure the harmony of theory and practice.

Organizing and conducting a physical experiment on surface tension forces.

Task 1.

Prepare the glass plate. Wash it thoroughly with soap and warm water. After drying, wipe one side with cotton wool soaked in cologne. Do not touch the surface of the record again; hold it only by the edge.

Take a small piece of white smooth paper and, by applying stearin dripped from a candle, form a smooth plate (the size of the bottom of a glass).

Place the glass and stearin plates side by side. Use a pipette to add a drop of water to each. On the surface of stearin, water forms a small sphere (half-sphere), while in glass, it spreads out. Try bending the glass plate – the water will flow out. This is explained by the stronger attraction of water molecules to the glass.

In stearin, however, water does not spread; it slides as a drop, as water molecules are more strongly attracted to one another.

Note: soot can also be used instead of stearin.

Task 2.

Lightly grease the safety razor blade with oil and carefully place it on the water's surface. A needle can be placed on top of it, and buttons can be placed on the ends. Nevertheless, it does not sink – the surface of the water holds it.

Even a needle, if placed very carefully, floats on the surface of the water. If it is magnetized, it can be moved by a magnet.

Task 3.

Place two identical plugs on the water's surface. Bring them together with matches. As the distance decreases, the plugs will automatically attract each other quickly. They can also be attached to the walls of the container.

Try to explain this phenomenon.

Task 4.

Take two glasses. Fill the first one with water and place it higher, and place the second one lower. Place one end of the cloth ribbon into the water, and the other end into the empty glass below. Water rises up through the fibers of the fabric and then flows down. This phenomenon operates on the basis of capillarity (related to surface tension).

Task 5. (Plato's experiment)

Mix water and alcohol to obtain a solution with a density close to that of oil. Pour it into a glass container and drip vegetable oil into it. The oil forms a sphere in the center.

In the mini-option: pour oil into a small container and drip a mixture of water and cologne into it. If the drop settles or rises, adjust the density of the mixture by adding water or cologne. As a result, the drop "hangs" in the oil.

Task 6.

Pour water into two plates to study the surface tension of the water. Cut thin pieces of paper and place them in a ring on the water surface.

Then, in one container, touch the soap to the center of the ring – the pieces of paper will disperse. And in the second, touch the sugar – the pieces will approach each other.

Question: How do soap and sugar change the surface tension of water?

Organization and conduct of a physical experiment on friction

Task 1.

Take a long, heavy book, tie it with a thin thread, and connect a 20 cm long rubber thread to the thread.

Place the book on the table and start pulling very slowly at the end of the rubber string. Measure the length of the stretched rubber thread when the book starts to slide.

Measure the length of the stretched thread when the book moves uniformly.

Place two thin cylindrical pencils (or two cylindrical pencils) under the book and pull the thread again. Measure the length of the string when the book moves smoothly on the rollers.

Compare the three results and draw a conclusion.

Note: The next task is also a continuation of the previous one. It aims to compare three types of friction.

Task 2.

Place the hexagonal pencil parallel to the back of the book. Slowly lift the top edge of the book until the pencil slips down. Then reduce the slope of the book slightly and secure it in this position with something.

Now, if you put the pencil back on the book, it won't slip. It is held in place by the force of static friction. However, it is sufficient to reduce this force slightly (for example, by lightly striking a book with a finger) – the pencil will slide down and fall onto the table.

(The same experiment can be performed in the same way with a pencil case, a matchbox, or an eraser.)

Think about it: why is it easier to remove a nail by turning it around the board?

It takes a certain amount of force to move a thick book across the table with one finger. If two round pencils or pens are placed under the book (they act as a roller bearing here), the book will move easily even with a very small push.

Task 3.

In this experiment, two phenomena can be observed simultaneously: inertia and friction.

Take two eggs: one raw, the other boiled. Wrap both eggs in a large plate. As you can see, boiled eggs behave differently than raw ones: they rotate much faster.

The whites and yolks of a boiled egg are tightly bound to the shell and are in a solid state with each other. When we open a raw egg, we first open only the shell, and only then, due to friction, does the layer-by-layer rotation shift to the protein and yolk. Thus, friction between the layers of liquid protein and yolk inhibits the rotation of the shell.

Note: Instead of raw and boiled eggs, you can insert two pots, one with water and the other with the same amount of groats.

Materials and Methods

In this study, methodological approaches aimed at determining the effectiveness of organizing experimental activities in teaching physics in grades 7-9 were applied. The research process utilized methods of pedagogical observation, comparison, experimental work, interviews, and analysis.

The following methodological approaches were taken as the basis for organizing experimental activities:

- applying demonstration experiments during the lesson;
- organization of laboratory work based on students' independent activities;
- systematic implementation of simple experiments performed at home;
- use of virtual laboratories and information technologies.

The study was conducted in grades 7-9 of general secondary schools. During the experimental work, students were divided into two groups: the control group (based on traditional teaching methods) and the experimental group (based on the proposed methodology). In both groups, the level of knowledge, practical skills, and interest in the subject were regularly assessed.

The content of the experiments covered the main sections of the physics course: mechanics (speed, friction, center of gravity), molecular physics (surface tension), and hydrostatics (pressure, Archimedes' force).

Results

The research results demonstrated that the educational process organized on the basis of experimental activity significantly improved the quality of students' knowledge. In particular, students in the experimental group:

- achieved a deeper mastery of physical concepts;
- measurement and observation skills have been developed;
- the ability to think independently and draw conclusions has been formed;
- interest and motivation for the subject increased.

Furthermore, experiments conducted at home activated students' extracurricular activities and strengthened the connection between theory and practice. It was found that the use of virtual laboratories is an effective tool for understanding complex processes.

Compared to the control group, the performance indicators and the quality of practical task completion in the experimental group were higher.

Discussion

The results obtained confirm that the systematic and purposeful use of experiments in physics education increases the effectiveness of the educational process. Experimental activity transforms students from passive listeners into active participants, which fully complies with modern educational requirements.

During the study, it was established that home experiments and simple experiments play a crucial role in developing students' creative thinking. However, in some cases, the lack of a material and technical base, time constraints, or insufficient methodological guidelines may hinder the full implementation of experiments.

Therefore, it is necessary to improve the methodological training of physics teachers, make extensive use of modern educational resources, and integrate experiments into the lesson process. Furthermore, it is possible to develop students' research competencies by encouraging them to conduct independent experiments.

In general, an approach based on experimental activity is an effective means of improving the quality of physics education, harmonizing theoretical knowledge with practice, and forming scientific thinking in students.

Conclusion

The results of this study showed that the systematic and purposeful organization of experimental activity in teaching physics in grades 7-9 significantly increases educational efficiency. Experiments are an important tool for strengthening students' theoretical knowledge, connecting it with practice, deepening their understanding of physical phenomena, and shaping scientific thinking.

During the study, it was established that the combined use of demonstration experiments, laboratory work, home experiments, and virtual laboratories develops students' level of knowledge, observation, and independent thinking skills. In particular, simple and safe home experiments serve as an effective tool for increasing students' interest in science and involving them in independent research activities.

It has also been proven that through the proper organization of experimental activities, students develop important competencies such as measurement, analysis, generalization of results, and drawing conclusions. As a result, the organic connection between theory and practice in physics education is ensured, and the quality of education increases.

Recommendations

1. Based on the research results, the following methodological proposals are put forward:
2. It is necessary to establish the regular and systematic use of experiments in physics lessons.
3. It is necessary to develop and implement a set of simple, understandable, and safe experiments for each topic.

4. To develop students' independent activity, it is recommended to increase the number of experiments performed at home.

5. It is necessary to provide physics classrooms with modern laboratory equipment and to improve mechanisms for their effective use.

6. is necessary to increase the efficiency of explaining complex physical processes through the extensive use of virtual laboratories and digital educational resources.

7. It is advisable to organize professional development courses to improve the methodological training of teachers and the organization of experimental activities for them.

8. Particular attention should be paid to developing skills in analyzing experimental results and expressing them in graphical and tabular formats.

9. It is recommended to increase the share of assignments aimed at developing students' creative and research abilities during the educational process.

The implementation of these proposals into practice will serve to improve the quality of physics education, form a scientific worldview in students, and educate them as individuals with modern competencies.

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