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METHODICAL PROBLEMS OF TEACHING PHYSICS IN MODERN SCHOOL

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Abstract

This article deals with the problems of teaching physics in the context of the introduction of Federal state educational standards of the new generation, both in secondary and higher education. In particular, this concerns the formation of the ability of students to work independently, as well as the use of educational techniques that allow achieving the planned educational results. The teachers' survey of junior students and schoolchildren showed that teachers assess their readiness for the organization of independent learning activities of students only by 50%, and students and schoolchildren assess their readiness for independent learning activities by 60%. Thus, the idea of developing a local methodology of teaching physics related to the implementation of independent experimental work of students started up. This article describes in details developed and tested author's method of performing independent experimental work in physics. The article contains examples of tasks with which this technique can be successfully implemented in the teaching process. The author's teaching experience shows that the use of this technique allows students to acquire skills that characterize the achievement of the planned educational results as a consequence of independent experimental activity.

Keywords: Interactive learning, methodology of independent experimental work in physics, planned educational results, the requirements of the new generation of FSES, readiness for the organization of independent learning activities of students, readiness for independent learning activities.

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1. Introduction

One of the main directions of the state policy in the field of education is increasing the objectivity of evaluation of educational results.

In accordance with the Federal state educational standards (FSES) of general and secondary education, the main object of evaluation of learning outcomes are specified results of development of the basic educational program in each educational subject.

'Planned results are a system of leading objectives and expected results of the development of all training programs in individual subjects, and interdisciplinary programs that form the informative basis of the educational program' (Fadeeva, Nikiforov, Demidova, & Orlov, 2014, p.6). The planned results in physics provide for changes in the requirements of experimental skills' formation (Fadeeva, Nikiforov, Demidova, & Orlov, 2014, p.17,18).

If earlier, within the framework of traditional methods of teaching physics, it was supposed to develop private practical skills, for example, such as the ability to use an ammeter and voltmeter to measure current and voltage, etc., now in accordance with the new requirements, students must master a generalized understanding of the use of methods of scientific knowledge. Furthermore, the transition from complex measurements to simple, but independently performed experiments is expected (Mäntylä, 2011; Bathgate, Schunn, & Correnti, 2014).

It would be a mistake to believe that students without special pedagogical support will learn independent cognitive activity and will be able to form their own abilities for independent learning themselves.

2. Problem Statement

Since the middle of the last century the directions of training "are polarized around its two characteristics: controllability and formation at trained ability "to get" knowledge independently" (Zimnaya, 2002, p.62). At the same time, according to Zimnaya, independent work of schoolchildren and students is "the least studied and widely discussed problem of education, both at school and at university. It necessarily corresponds to the organizing role of the teacher" (Zimnaya, 2002, p.249). According to Zimnaya, independent work of the student "requires prior training techniques, forms and content of this work" (Zimnaya, 2002, p. 260). Thus, the most important function of the teacher in any ways and learning is to assist the student.

We agree to the opinion of Prokopiev and Mikhalkovich that independent work of students "is the highest form of educational activity for which special training is required (Prokopiev, 2002). The history of the development of forms and organization of training indicates that a reduction of the role of the teacher in the educational process necessarily entails a reduction in the level of pupils" (Prokopiev, 2002, p. 321).

Therefore, in the framework of this study, the task was to assess the level of readiness for the organization, as well as the most independent activities of all participants in the educational process. And, on the basis of the received data, to offer methodical decisions which will facilitate the formation of students' readiness and ability to the independent educational activity.

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3. Research Questions

As practice shows, teachers-theorists consider priorities of students' formation of abilities to work independently and think creatively during the process of transferring knowledge and development of skills. At the same time the existing practice of teaching mainly focused on the passive assimilation of knowledge, i.e., the priority is given to reproductive learning methods (Beerenwinkel & Matthias von Arx, 2016).

Our studies have shown that teachers evaluate their readiness to organize independent learning activities of students by 5 points out of 10.

Students and pupils assess their readiness for independent learning activities by 6 points out of 10.

The results of the survey show that even with a certain ability to work independently, students and schoolchildren note the slow perception of educational material when reading and summarizing educational texts.

Thus, it is possible to state insufficient formation of participants' skills of educational process to the organization and self-organization of educational independent work.

Therefore, there is a problem of formation of students' ability to independent work. As we have already noted, these abilities can be formed as a result of joint actions of teachers and students (Jurik, Gröschner, & Seidel, 2014). To solve this problem, in our opinion, it is necessary to equip teachers with the necessary knowledge on the use of special educational techniques in practice Please replace this text with context of your paper.

4. Purpose of the Study

The purpose of our study is to develop a methodology for the organization of independent experimental work.

5. Research Methods

To solve the tasks we used such research methods as:

- analysis of psycho0-pedagogical and scientific-methodical literature; study of normative documents devoted to the strategy of education development in modern society;
- theoretical methods of research of methodical problems (analysis and synthesis, generalization), design and modeling of educational process;
- experimental methods and forms of work (study of stating, searching and formative nature with the use of questionnaires; observations of pedagogical phenomena; personal teaching in schools and universities; interviews, surveys of teachers, students and pupils, as well as the testing and implementation of the proposed solutions).

6. Findings

To solve the above-mentioned problem of research, we have developed a technique for performing independent experimental work in physics.

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For independent execution of experimental tasks in physics, a student along with the task receives a written manual that allows a student to perform the physics experiment correctly.

When making a manual, it is necessary to take into account the fact that in the educational process it is impossible to require students to perform absolutely all stages of the study independently. However, the greatest degree of independence in this process will contribute to the familiarity of students with the structure of scientific research, as well as the formation of scientific thinking of students. We consider it is important to recall that " scientific thinking is characterized by:

1) clear statement of the purpose of the study;

2) development of hypotheses;

3) development of research methodology;

4) identification of the main stages of the study;

5) the actual study in accordance with the developed methodology and plan;

6) analysis of the obtained results;

7) formulation of conclusions" (Razumovsky, Bugaev, & Dik, 1984, p.232).

Therefore, during implementation of independent experimental work the written manual may include a list of the following questions:

- What is the purpose of Your work?
- What equipment do You need to achieve the goal?
- What actions did You take in the course of the work?
- What results have You obtained?
- What conclusions were You made on the basis of the results?

The answers to these questions allow students to prepare a report for public defense.

Our experience shows that students successfully cope with the proposed tasks with minimal teacher's support. The success of the work is also ensured by the fact that students work in small groups, where mutual assistance is carried out in the framework of interactive interaction, an exchange of views also takes place.

As practice shows, for effective work in each group there should be no more than four people, otherwise the level of independence decreases (Caleon, Tan, & Cho, 2017).

Each member of the group takes part in the defense. In preparation for the defense there is an established agreement between members of the group on who will speak and what information the speaker will use. Obligation of a performance provides students' activity and responsibility.

The process of defense is accompanied by questions from both sides: teacher's side and student's side.

After the defense, the teacher evaluates the work of the whole group, and students carry out mutual evaluation of each group member taking into account the labor participation rate.

Here are examples of simple experimental tasks that were used by us during the lesson on the topic "Mechanical vibrations".

The task of the first group:

Check whether the period of vibration of the mathematical pendulum depends on its length, mass and angle of deviation of the pendulum from the equilibrium position (angle not more than 20 degrees).

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Note that the length of the pendulum is the distance from the suspension point to the center of mass of the pendulum.

The task of the second group:

It is known that the period of vibrations of the mathematical pendulum does not depend on the weight of the load suspended on the thread. Will the period of vibration be the same if there are one or two (connected in series with hooks) weights suspending on the thread?

The task of the third group:

Determine the area of the table, using only a thread pendulum and stopwatch.

The task of the fourth group:

To determine the period of vibration of the pendulum-meter thread. What will it be equal to, if the length of the pendulum is reduced by four times?

The task of the fifth group:

Determine the stiffness coefficient of the rubber thread, using a weight of 0.1 kg, a stopwatch and a ruler.

The task of the sixth group:

How to change the frequency of the vibrations of a pendulum with an iron load, if the magnet is put under it (Gorodetsky & Penkov, 1987)?

During such lesson, the student learns to recognize the problems that can be solved by physical methods; analyze the individual stages of research and interpret the results of observations and experiments. In the context of the FSES, a graduate will have the opportunity to learn:

- understand the role of experiment in obtaining scientific information;
- independently carry out indirect measurements and studies of physical quantities using different methods of measurement of physical quantities, choose the means of measurement taking into account the necessary accuracy of measurements, justify the choice of measurement method, adequate to the task, to assess the reliability of the results;
- create your own written and oral reports on physical phenomena based on several sources of information;
- work in a group of peers in solving cognitive tasks, plan joint activities, take into account the opinions of others and adequately assess their own contribution to the group.

In addition, as a result of independent experimental activity a student will acquire skills that characterize the achievement of planned educational results, such as:

1) recognition of problems that can be solved by using physics methods;
2) analysis of individual stages of research: the hypothesis being tested, the order of observation or experience, presentation of results;
3) interpretation of observations or experiments.

The criteria for achieving the planned result are the correct conclusions.

Despite all the positive aspects of such studies, it should be noted that in conditions of lack of time allocated to the study of physics, it is completely impractical to decline traditional classes. Since the active and interactive forms of training sessions are very time-consuming. Therefore, the teacher should find a

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balance between the various forms of organization of students' cognitive activity, based on the principle of "There is a measure in all things".

7. Conclusion

Reduction of time for studying of separate subjects (disciplines) and necessity of consolidation of educational information led to that now the quantity of the studied information contradicts to quantity of time which is taken away on studying of separate disciplines, including physics. The time allocated for classroom studies at the University in some disciplines (including physics) has been reduced to 50-70 %. In high school, the time spent on the study of school physics course is also reduced by 50%.

That is why, we need such approach to the organization of cognitive activity of students is necessary, which will allow to level deficiency of educational time. In addition, as noted above, a significant quality of personality nowadays is independence.

Thus, only that training becomes relevant, in which knowledge is transferred to students and schoolchildren in a not prepared form but are mastered by them independently. But, as practice shows, self-study of educational material significantly increases the time of its assimilation, and students are not fully ready to work independently with educational information.

Therefore, it is clear that the educational process is in need of such methodological decisions (educational technology, methodology) that will solve these problems and increase the effectiveness of the cognitive activity of the learners.

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