

DEVELOPING STUDENTS' UNDERSTANDING AND ANALYTICAL SKILLS THROUGH THE APPLICATION OF METACOGNITIVE STRATEGIES.

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Abstract: this article analyzes the importance of developing metacognitive skills when teaching physics in secondary schools. Metacognitive knowledge and management strategies, their impact on student learning, as well as the theoretical and practical foundations of metacognitive approaches are examined.

Key words: metacognition, metacognitive improvement, physics teaching, student behavior, teaching methods.

Introduction.

World-renowned scientific schools and prestigious universities are conducting consistent research on the introduction of metacognitive strategies into the educational process. Modern approaches aimed at developing students' independent thinking are widely used in universities such as Cambridge, Harvard, Stanford, Utrecht, and Melbourne, as well as in countries with advanced education systems such as Finland, England, and Singapore. In physics, these approaches are implemented through thinking aloud, asking oneself questions, learning diaries, classroom reflection, and interaction with peers. They form students' skills in understanding, analyzing, and independently choosing learning strategies. In scientific centers and innovative schools, classes are organized based on metacognitive models, which develop not only theoretical knowledge, but also the potential of strategic thinking and reflexive analysis. The development of metacognitive activity is one of the priority areas of modern education and plays an important role in increasing the competence of students, especially in subjects requiring a logical and analytical approach, such as physics.

In the modern education system, the ability of students to understand and analyze, process information, and independently control their understanding is becoming increasingly important. Metacognitive skills help students understand how they can apply their knowledge in learning activities. These skills are especially necessary in teaching complex subjects like physics, as this subject encompasses experimental and theoretical concepts and requires independent thinking from students. Metacognitive skills help students develop independent learning strategies in the learning process and effectively manage their learning activities.

As a result of the attention paid to the education system in our country, fundamental reforms, the creation of organizational and pedagogical conditions and a material and technical base for teaching, the provision of qualified personnel, and the widespread use of advanced international experience, the widespread introduction of innovative educational technologies into educational activities has been achieved. There is also a need to introduce into practice teaching methods aimed at the development of metacognitive activity in physics. This further increases the need to improve students' metacognitive skills in teaching physics in general education schools.

Literature analysis.

There is a lot of research in the field of application and study of metacognitive activity in physics teaching. Research in this area helps to understand how students learn physics, how they choose learning strategies, and how they evaluate their knowledge. David Hammer, a renowned



scholar in the field of educational psychology, deeply studies how students learn physics [1, p. 40-90]. In his research, Hammer analyzes students' intuitive concepts and how these concepts can be integrated with formal physics knowledge. Her work shows how to teach students to independently evaluate and analyze their knowledge by developing metacognitive thinking. Eric Mazur, Professor of Physics at Harvard University, developed "Peer Instruction" - a peer teaching method. This method encourages students to learn through interaction and develops their metacognitive skills [2, p. 30-45]. This tutorial helps students learn how to gain a deeper understanding of physics concepts and how to solve complex problems. José Mestre conducted extensive research on the application of metacognitive approaches in the teaching and learning of physics. Her work focuses on how students analyze and evaluate their thinking activities in their physics activities [3, p. 45-69]. Mestre also demonstrates how metacognitive skills can enhance students' ability to solve complex physics problems. Stella Vosniadou is a well-known scholar in the field of educational psychology, who particularly studies how students shape their scientific understanding and the role of metacognitive strategies in this activity. Vosniadou aims to teach students how to integrate their knowledge in their physics activities and add new information to the existing knowledge system. These scientists and their works demonstrate the effectiveness of applying metacognitive activities in physics teaching and create an important basis for integrating these activities into educational practice. They emphasize the importance of metacognitive skills in developing students' independent learning abilities and effectively managing their knowledge.

The works of scientists on metacognitive activity in teaching physics are also valuable. Research conducted in this area is mainly aimed at developing teaching methods and students' self-analysis skills. Sergey Polat is a well-known educator and methodologist in the field of education in Russia. His work is mainly focused on the development of new pedagogical technologies and teaching methods. Sergey Polat emphasizes the importance of applying metacognitive approaches in education, considering these approaches particularly effective in teaching exact sciences such as physics. Her work helps teachers develop lesson plans that encourage students to think independently and understand their knowledge more deeply [4, p. 30-45]. Elena Kazakova, known as an expert in the methodology of teaching physics. Her work focuses on how students can effectively manage their knowledge [5, p. 50-65]. Kazakova demonstrates that metacognitive skills can enhance students' ability to solve complex physical problems. It provides lesson plans that allow students to self-assess and analyze their own thoughts. Rahmatulla Nuriddinov's work is mainly focused on the development of interactive teaching methods and the application of metacognitive approaches in education. Nuriddinov pays special attention to the development of students' abilities for self-analysis and independent problem-solving, which helps to increase the level of understanding of students, especially in such subjects as physics [6, p. - P. 65-116].

Methodology.

The study used methods of literature analysis, empirical research (questionnaires, observations, and experiments), and statistical analysis. Special questionnaires were compiled to measure and assess students' metacognitive skills. Through experiments, the results of students' application of metacognitive strategies were observed and analyzed. The 300 students who participated in this study were divided into two groups: experimental and control. Metacognitive strategies were used in the experimental group, while traditional methods were continued in the control group. Through questionnaires and observations, students' knowledge and metacognitive skills were assessed.

In conclusion, new methodological developments that activate metacognitive activity contribute to making physics teaching more interactive and effective. These developments



ensure students' effective management of their learning activities, which increases their scientific thinking and independent learning abilities.

The activity of testing modern teaching methods and tools is important for assessing the effectiveness of these methods and tools and determining their compatibility with educational activities. In the testing process, new methods and tools are initially used in the experimental groups, during which preliminary results are collected based on the observations of teachers and educational specialists. Above, with the help of examples from general physics, this activity was considered in detail (Fig. 3-4).

When observing the process of independent work (see Fig. 4), the ability of students to independently perform experiments, record and analyze the results is assessed. It analyzes how students overcame difficulties encountered during independent activities and what solutions they found.

During the experiments, a special lesson plan was developed to teach students metacognitive strategies. According to this plan, students performed various exercises on planning, monitoring, and evaluating their learning processes. For example, after each lesson, students wrote a diary for self-assessment and analysis of their activities. They wrote down the difficulties they encountered during the lesson and what solutions they found for them.

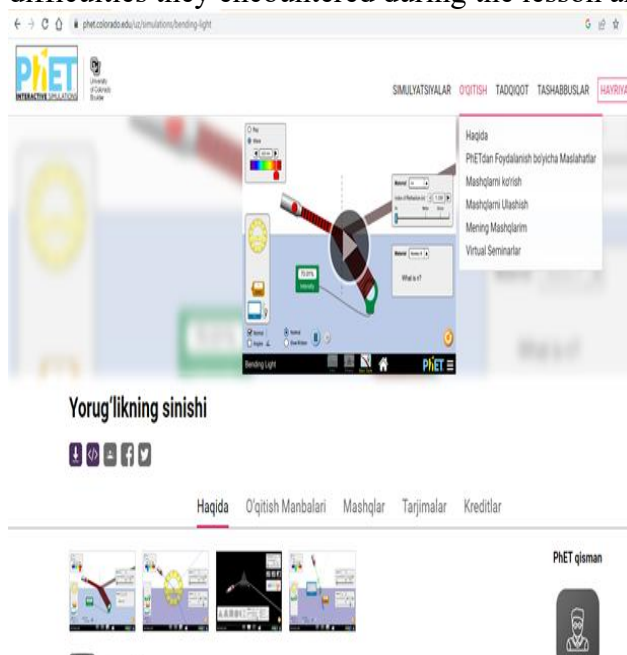


Figure 3. Introduction to the PheT program. Program working window

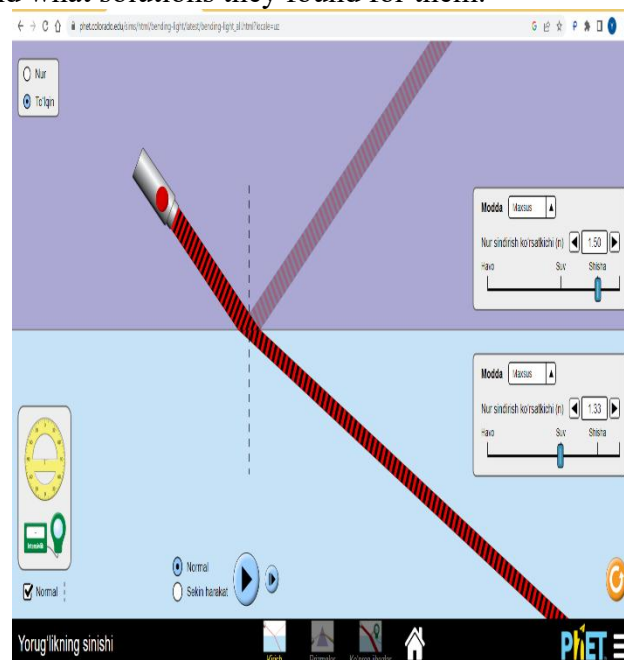


Figure 4. Analysis of the results obtained from the virtual laboratory

The control group was trained using traditional teaching methods, and they were not given any special exercises on the application of metacognitive strategies. Data were collected based on specially prepared questionnaires and observations to measure students' self-assessment and self-management skills. These data were statistically analyzed, and the results of the experimental and control groups were compared.

Skill Type	Experimental group (%)	Control group (%)
Self-assessment	85	60
Self-control	80	55
Solving complex problems	90	65



Skill Type	Experimental group (%)	Control group (%)
Self-study	88	62

Table 1. Results of the assessment of students' metacognitive skills**Results of the experiment.**

The results of the experiment showed that students who used metacognitive strategies achieved significantly higher results in physics. They demonstrated high abilities in the selection and application of effective strategies for solving complex problems. Students of the experimental group developed the ability to self-assess and effectively manage their knowledge in educational activities. The results of the statistical analysis showed significantly higher results in the experimental group compared to the control group. These results confirm that the application of metacognitive strategies plays an important role in increasing the success of students in teaching physics. At the same time, the development of students' metacognitive skills serves to increase self-awareness and independent learning abilities.

Conclusion

1. Metacognition plays an important role in the field of education and develops students' skills in understanding and managing their knowledge. Metacognitive skills help students independently manage their learning activities, choose and apply learning strategies. These skills educate students as more independent and creative individuals in the educational process and contribute to improving the quality of education.

2. Metacognitive approaches are extremely important in teaching physics. These approaches help students apply theoretical knowledge in practice and gain a deeper understanding of complex concepts. As a result, students develop the ability to think critically, they are inclined to independently solve complex problems and acquire new knowledge. With the help of metacognitive strategies, students learn to effectively manage their learning activities, and their interest in physics increases.

3. Metacognitive skills offer students opportunities for independent learning, increasing effectiveness, and problem-solving. Metacognition is an important tool in the field of education that ensures effective management by students of their learning activities and strategies. This enriches learning activities by increasing self-awareness and coordination skills, and makes students more independent and effective learners. As the research results show, the application of metacognitive strategies significantly improves the quality of students' learning and increases their success in physics. Therefore, the widespread use of metacognitive approaches in teaching physics in general education schools is recommended.

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