



DEVELOPING STUDENTS' INDEPENDENT THINKING AND MATHEMATICAL PROBLEM- SOLVING SKILLS

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Annotation. *This article analyzes the theoretical foundations and practical approaches to developing students' independent thinking and problem-solving skills. Effective methods of activating the thinking process of students in mathematical education, forming in them analysis, comparison, generalization, and a creative approach are considered. The importance of problem-based learning, interactive methods, digital technologies, a differentiated approach, and metacognitive strategies in the development of students' skills in solving mathematical problems based on various strategies is substantiated. The research results show that creating an educational environment that activates students, forming high-level mathematical competencies in them, and strengthening the process of independent thinking is an important factor in increasing the effectiveness of education.*

Keywords. *Independent thinking, solving mathematical problems, problem-based learning, interactive methods, mathematical thinking, metacognitive strategies, differential approach, digital technologies, learning activities, cognitive skills.*

In the modern educational process, one of the urgent pedagogical tasks is the development of students' skills in independent thinking and solving mathematical problems. In the context of globalization, the ability to analyze complex situations, draw logical conclusions, and

creatively approach various mathematical problems is one of the important factors determining a person's competitiveness. Therefore, in mathematics education, it is necessary to introduce methodological approaches that teach the student not to master knowledge in a ready-made form, but to search, to reason logically, to consider the problem from different points of view.

In recent years, the widespread introduction of pedagogical technologies, interactive methods, and innovative directions has had a significant impact on the thinking process of students. In particular, the use of problem-based learning, project activities, problem-based learning, a differentiated approach, and elements of mathematical modeling activates students' independent thinking and increases their interest in solving problems of various levels. The effectiveness of these methods is important not only in the formation of skills for understanding and applying knowledge, but also in the formation of high-level cognitive activity, such as analysis, comparison, generalization, and the identification of logical connections.

The process of solving a mathematical problem includes such stages as the student's understanding of the problem, choosing a solution strategy, arriving at a conclusion based on logical thinking, and evaluating the result. Each of these stages serves the intellectual development of the student. Therefore, mathematics is considered not only as a set of calculations, but also as a means of forming students' thinking, preparing them for making rational decisions in life situations.

The issue of developing students' independent thinking and skills in solving mathematical problems has been widely studied in international and domestic scientific research, most of which are aimed at improving

the content, methods, and process of cognitive development of mathematical education.

The theoretical foundations of independent thinking were substantiated by such pedagogical and psychological scientists as J.Dewey [1], L.Vygotsky [2], J.Bruner[3]. J.Dewey, emphasizing the need to base the educational process on the active experience of the student, put forward the idea of forming thinking through problem situations. According to L.Vygotsky's concept of the "zone of proximal development," the student develops logical thinking in the process of solving complex problems with the help of adults. J.Bruner substantiated the formation of strategies for independent problem-solving in students through the model of teaching through discovery.

At the international level, the work of G. Polya [4] on solving a mathematical problem is of particular importance, who proposed a four-stage approach, such as understanding the essence of the problem, choosing a strategy, implementing the solution, and re-analyzing the result. Later, M. Schoenfeld [5] conducted an in-depth analysis of the role of metacognitive strategies, time management, and appropriate thinking strategies in solving mathematical problems.

Issues of forming the process of independent thinking and developing mathematical competencies are also widely covered in domestic research. In particular, scientists such as A.Abdukodirov [6], R.Mavlonova [7], N.Turakulov [7], Sh.Yuldashev [7] have proposed scientific developments on innovative approaches to mathematics education, problem-based learning, and the methodology of developing logical thinking. In these studies, recommendations were put forward on the selection of mathematical problems in accordance with the age and

psychological characteristics of the student, the application of a differentiated approach, and increasing student activity based on interactive methods.

Also, the results of the PISA (2018, 2022) international assessment program show that students' mathematical literacy is directly related to their skills in problem analysis, mathematical modeling in real-life situations, and logical reasoning. This confirms the need to abandon traditional reproductive methods and widely introduce analytical and research-based methods in mathematics education.

Research in recent years on the use of digital technologies, the simulation environment, online platforms, and interactive programs shows that they are expanding opportunities for developing students' creative thinking and solving mathematical problems with innovative solutions [8, 9]. In particular, the "productive failure" model substantiates that students first independently search and then master the corrected solution, forming in them a deep understanding and appropriate thinking strategies [9].

This analysis shows that the development of students' independent thinking and skills in solving mathematical problems is a multifactorial process, which is closely related to psychological mechanisms, methodological approaches, technologies for creating problem situations, and the modernization of the educational environment. The scientific views put forward in the literature form the theoretical basis of the research on this topic.

The formation of students' skills of independent thinking and solving mathematical problems is one of the main goals of the modern educational process, and these skills are important not only for

deepening students' knowledge of mathematics, but also for finding rational solutions in real-life situations. The problem-solving process requires cognitive processes from the student, such as logical thinking, analysis, comparison, generalization, imagination, and decision-making. Therefore, in mathematics lessons, it is necessary to use methods that increase student activity, encourage them to think, and direct them to solve problems in various ways.

The process of solving a mathematical problem consists of a number of stages, and the model proposed by G. Polya is still relevant. According to this model, the student first understands the essence of the problem, analyzes the given conditions, and determines what type the problem belongs to. In the second stage, he chooses the appropriate strategy for solving the problem: whether it is an arithmetic method, an algebraic approach, geometric representations, or logical analysis - all this depends on the student's level of thinking. In the third stage, the chosen strategy is applied in practice, a solution is sought, and various options are checked. In the final stage, the student reviews the solution, assesses its correctness, logic, and possibilities of generalization. Such a step-by-step approach activates students' independent thinking, encourages a creative approach to the issue among them.

Interactive methods used in the educational process, including such techniques as "Problem-based learning," "Brainstorming," "Cluster," "FSMU," "Analytical conversation," are effective in activating the thinking process in students. By creating problem situations, the student independently analyzes the problem, applies their previously acquired knowledge in a new situation. In this process, the teacher acts not as a ready-made solution, but as a guide, a consultant. It is in such an

environment of self-learning that the student's independent thinking is formed.

The use of ICT tools in solving mathematical problems is also an important factor in increasing the cognitive activity of students. The use of dynamic geometric programs (GeoGebra, Desmos), virtual laboratories, simulations, and educational platforms (Khan Academy, Matific) allows students to visually understand mathematical processes. This contributes to the assimilation of abstract concepts, expands the possibility of considering various approaches to the issue. Problem-based tasks built on the basis of digital technologies increase students' research activity, develop their skills of independent analysis and drawing conclusions.

The differential approach also plays an important role in the development of mathematical thinking in students. Due to the fact that each student has different levels of thinking, experience in problem-solving, and the speed of assimilation, it is effective to stage problems according to the level of complexity. Combining easy, medium, and high-level problems increases students' self-confidence and gradually prepares them for a complex logical process.

In addition, the use of metacognitive strategies in the process of solving a mathematical problem is of particular importance. The student's ability to control their thinking process, to understand at what stage they made a mistake, to revise their strategy increases the quality of their thinking. Studies show that teaching students to analyze their thinking process significantly improves their mathematical results.

In general, the development of independent thinking and skills in solving mathematical problems is a continuous pedagogical process, in

which the main factors are effective teaching methods, a system of problem tasks, an appropriate educational environment, the harmonious use of technologies and ICT tools that stimulate student activity. Proper organization of this process develops not only the mathematical competencies of students, but also their general intellectual potential.

The development of students' independent thinking and skills in solving mathematical problems is one of the priority areas of modern education, and this process serves to expand the intellectual potential of students, form their analytical approach and creative thinking. During the study, theoretical views, scientific sources on the development of these skills were analyzed, and effective methodological approaches were substantiated.

In particular, it was established that problem-based learning, interactive methods, digital technologies, and differential approaches activate the process of independent thinking in students, forming the ability to solve a mathematical problem using various strategies.

In the process of solving a mathematical problem, the effective use by the student of the stages of understanding the problem, choosing a strategy, implementing the solution, and analyzing the result develops their logical thinking. Also, the application of metacognitive strategies, that is, the student's ability to control and evaluate their thinking process, further strengthens their competence in solving problems independently. The purposeful use of digital educational tools makes it possible to master abstract mathematical concepts in a visual and interactive form, which encourages students to actively search.

In general, the formation of independent thinking and skills in solving mathematical problems in students is a complex pedagogical

process, which is closely related to teaching methods, the learning environment, student activity, and the guiding role of the teacher. In this direction, the content of mathematical education will be raised to a qualitatively new level by improving the educational process on a scientific basis, introducing innovative approaches, and increasing the cognitive activity of students. As a result, students not only acquire deep knowledge of mathematics, but also develop as individuals capable of making correct, logical, and well-founded decisions in life situations.

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