

## METHODOLOGICAL FOUNDATIONS FOR TEACHING HOW TO SOLVE COMPLEX PROBLEMS IN PRIMARY SCHOOL MATHEMATICS

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### **Abstract**

This article deeply analyzes the methodological foundations of teaching complex problem-solving in primary school mathematics lessons. The research aims to define the concept of complex problems, uncover their pedagogical and psychological bases for instruction, and systematize effective strategies such as G. Polya's methodology, heuristic methods, and visualization.

### **Keywords**

Primary school, mathematics, complex problems, problem-solving methodology, heuristic methods, pedagogical principles, visualization.

One of the main tasks of the modern education system is not only to arm the younger generation with a body of knowledge, but also to form their skills in independent thinking, navigating problematic situations, and finding creative solutions. In this process, mathematics plays a decisive role, especially in the primary grades. Through problem-solving in mathematics lessons, students develop cognitive abilities such as logical thinking, analysis, synthesis, and generalization. Along with forming the skill of solving simple problems, teaching how to discuss and solve complex problems is an important factor in increasing their intellectual potential.

In primary school mathematics lessons, problems are mainly divided into two types: simple and complex. Simple problems are those that are typically solved with a single arithmetic operation, leading directly to an answer. For example, "There were 3 apples, and 2 more apples were added. How many apples are there in total?" Complex problems, however, are those that have a multi-step solution, require several arithmetic operations, or lack a direct algorithm to reach a solution. The process of solving them requires the student to engage in analysis, synthesis, comparison, logical thinking, and a creative approach to the problem.

From a pedagogical perspective, teaching complex problems is inextricably linked with L. Vygotsky's theory of the "zone of proximal development." According to him, tasks that a child cannot perform on their own but can solve with the help of a teacher or another experienced individual are considered the most effective for their intellectual development. Complex problems are precisely such tasks, serving to expand the child's cognitive boundaries. J. Piaget's theory of cognitive development stages is also important in this process. Although primary school students are mainly in the concrete operational stage, they can take the first steps towards abstract thinking through complex problems.

From a psychological standpoint, solving complex problems develops logical, critical, and creative thinking in children. This process increases intellectual activity and strengthens students' motivation toward the problem. Complex problems push students to draw conclusions, put forward hypotheses, test them, and search for the most effective solution paths. As Siddiqov and Tursinalieva note, complex problems hold a central place in developing the logical thinking and problem analysis skills of primary school students, because they engage students not only in finding a solution but also in the process of seeking various options and making independent decisions.

To increase the effectiveness of teaching how to solve complex problems, there are a number of methodological principles and practical strategies. The foundation of these is G. Polya's famous "How to Solve It" methodology. Polya proposes a four-step solution process:

**Understanding the problem:** Students must clearly identify what is given and what is being asked in the problem.

**Devising a plan:** Developing a strategy for how the problem might be solved. At this stage, methods such as recalling similar problems, breaking the problem into parts, and drawing a diagram are used.

**Carrying out the plan:** Solving the problem step-by-step in accordance with the devised plan.

**Looking back:** Checking the correctness of the obtained result and its correspondence with the problem's conditions.

Heuristic methods give students the opportunity to think for themselves when solving complex problems. These include inductive (moving from specific cases to a general principle) and deductive (determining a specific case from a general principle) approaches, and strategies such as simplifying the problem and working backwards (moving from the solution toward the condition). A problem-based learning approach engages students in an active intellectual process, shaping them

not as recipients of ready-made knowledge, but as individuals who create knowledge.

The problem decomposition strategy is especially effective for elementary school students. In this approach, a complex problem is divided into several simple parts, each part is solved individually, and then the results are combined into a final solution. Visualization methods also significantly simplify the understanding of complex problems. Drawings, diagrams, tables, charts, and models provide the opportunity to visually represent the content of the problem. Research conducted by M.E. Jumayev on the methodology of using visual aids also highlights the importance of such approaches in primary school mathematics lessons. These methods are particularly helpful in making abstract concepts concrete and understanding the internal logic of a problem. A systematic approach and the principle of progressing from simple to complex ensure the gradual development of students.

The teacher's role is central to teaching how to solve complex problems. They should not merely be a conveyor of knowledge but must act as a facilitator who guides, encourages, and supports the students' learning process. The teacher should not provide ready-made solutions, but rather challenge students to think independently, propose their own hypotheses, and test them. To achieve this, methods such as asking questions, offering advice, and helping to analyze various aspects of the problem are important.

Encouraging students' independent work is the foundation for developing complex problem-solving skills. The teacher must give them creative freedom, push them to seek various solution paths, and support each student's individual solution strategy. Group work and discussions help students learn from one another, exchange ideas, and listen to different perspectives. This, in turn, develops their collaboration skills and fosters a comprehensive approach to problems.

Creating a creative environment is also important. This means fostering a classroom where there is no fear of making mistakes, where experimentation is encouraged, and where there is an opportunity to learn even by analyzing incorrect solution paths. The teacher should show students that a problem may have multiple solutions or that it can be solved in various ways. A differentiated approach is also of great importance; the teacher should present problems of varying complexity, taking into account the individual abilities and knowledge levels of the students, and create conditions for each child to fully realize their potential.

In Uzbekistan's primary education system, current textbooks and curricula give some attention to teaching complex problems, but they often remain within

the framework of standard, typical problems. This does not provide sufficient opportunities for students to develop logical and creative thinking in non-standard situations.

The existing issues are mainly apparent in several areas. Firstly, there is a noticeable lack of methodological preparedness among teachers for teaching complex and logical problems. Many teachers themselves face difficulties in solving such problems, which hinders their ability to effectively guide students. Secondly, students have poor logical thinking skills and a lack of motivation to solve problems. Thirdly, the excessive focus on the testing system in the educational process can push students towards memorization, hindering the development of independent thinking and problem-solving skills.

In teacher professional development courses, special attention should be given to complex problems, heuristic methods, and problem-based learning methodologies. These courses should be practice-oriented and help teachers adopt new perspectives.

**Conclusion:** teaching students to solve complex problems in elementary school mathematics lessons is of great importance for their cognitive development and the formation of logical and critical thinking skills. This study discussed the theoretical foundations of complex problems and highlighted effective methodological strategies such as G. Polya's methodology, heuristic methods, breaking problems into parts, and visualization. The guiding and encouraging role of the teacher, as well as the need to create a creative and collaborative environment, was noted. Some existing problems in this area within the education system of Uzbekistan were identified, specifically, issues with the methodological preparedness of teachers and the standardized nature of problems in textbooks.

As future research directions, tasks such as developing standards for assessing complex problem-solving skills, studying the possibilities of integrating innovative technologies (virtual and augmented reality, interactive programs) into the educational process, as well as improving teacher training models, are put forward.

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