



STANDARD PROBLEMS IN THE MATHEMATICS COURSE

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ANNOTATION

This article systematically analyzes the content, didactic tasks and teaching methodology of standard problems in the mathematics course. A standard problem is interpreted as a task that allows the student to apply a previously learned formula, rule or algorithm based on a certain condition. The study distinguishes arithmetic, algebraic, geometric, functional and practical-contextual forms of standard problems. The process of solving them is covered based on the stages of understanding the condition of the problem, determining known and unknown quantities, choosing a mathematical model, executing the algorithm, checking the result and interpreting the answer in terms of content. An analysis of the scientific literature shows the need to organize standard problems not only as mechanical exercises, but also as a tool for developing conceptual understanding, procedural fluency, flexible thinking and metacognitive control.

Keywords: standard problem, mathematical model, algorithm, problem solving, mathematical literacy, procedural knowledge, conceptual knowledge, metacognition, algorithmic thinking, mathematical competence.

СТАНДАРТНЫЕ ЗАДАЧИ В КУРСЕ МАТЕМАТИКИ

АННОТАЦИЯ

В данной статье систематически анализируются содержание, дидактические задачи и методика преподавания стандартных задач в курсе математики. Стандартная задача интерпретируется как задача, позволяющая



студенту применить ранее изученную формулу, правило или алгоритм на основе определенного условия. В исследовании различают арифметические, алгебраические, геометрические, функциональные и практико-контекстуальные формы стандартных задач. Процесс их решения рассматривается на основе этапов понимания условия задачи, определения известных и неизвестных величин, выбора математической модели, выполнения алгоритма, проверки результата и интерпретации ответа с точки зрения содержания. Анализ научной литературы показывает необходимость организации стандартных задач не только как механических упражнений, но и как инструмента развития концептуального понимания, процедурной беглости, гибкого мышления и метакогнитивного контроля.

Ключевые слова: стандартная задача, математическая модель, алгоритм, решение задач, математическая грамотность, процедурные знания, концептуальные знания, метакогниция, алгоритмическое мышление, математическая компетентность.

In mathematics education, problem solving is one of the central tools that transforms student knowledge into practical activity. When working with a problem, the student learns not only to calculate, but also to separate the given information, determine the necessary relationship, choose a method and evaluate the result obtained. Polya explained the problem-solving process through the stages of understanding the problem, making a plan, implementing the plan and revising the solution. This approach also serves as an important theoretical basis for organizing problem-solving as an orderly process of thinking in today's mathematics methodology. Mathematical problem solving is not limited to performing a procedure. Schoenfeld's research shows that, along with knowledge and algorithms, strategic action, control and the student's management of his own thinking process are also important. Therefore, even when teaching standard problems, the student should not be satisfied with the question "which formula should I use?", but should



be able to ask questions such as "why this formula?", "is the result consistent with the content?". An important requirement of modern mathematics education is the ability of students to apply mathematical knowledge in real-world situations. The concept of mathematical literacy within the framework of PISA considers mathematization of the situation, use of relevant concepts and procedures, interpretation and evaluation of the result as interrelated activities. These requirements also require strengthening the content approach in teaching standard problems.

Standard problems constitute the main practical layer of the lesson. They allow to consolidate new concepts and formulas, to form accuracy and fluency in student activity, and to prepare for more complex tasks. However, the use of standard problems in the same form, excessively and mechanically can teach students to work based on the appearance of the problem rather than its content. Therefore, the methodological redesign of standard problems themselves is one of the urgent issues of today's mathematics education.

A standard problem is a task in which the mathematical method, formula, or algorithm necessary for the solution is known to the student, and the condition of the problem provides sufficient information to apply this method. ⁸ For example, tasks such as solving a linear equation, calculating the area of a right rectangle, finding the value of a function in a given argument, or determining a percentage can be standard problems within the relevant topic.

The didactic value of a standard problem is evident in three aspects. The first is the transformation of theoretical knowledge into practical action. The student sees the content of the formula or rule in real activity through the problem. The second is the formation of procedural fluency. Consciously performing the same action under different conditions increases the accuracy and speed of calculations. The third is to create a basis for complex problems. Only when the student has mastered simple structures can they be used in new combinations.



Standard problems can be divided into arithmetic, algebraic, geometric, functional, and practical-contextual groups according to their mathematical content. In arithmetic problems, operations on numbers, shares, ratios, percentages, proportions, and quantities are prioritized. In algebraic problems, work with equations, inequalities, identities, and formulas is assumed. In geometric problems, it is important to find the length, perimeter, area, volume, and angle quantities based on certain laws.

In functional standard problems, operations such as using a formula, table, or graph are performed, and determining the value of a function when the argument changes. In practical-contextual problems, mathematical tools are applied to real-life situations such as purchasing, time, distance, production, energy consumption, or financial calculations. Such a classification provides the teacher with a convenient diagnostic basis for determining in which type of mathematical activity the student is experiencing difficulties.

In solving a standard problem, the following sequence is appropriate: understanding the problem; distinguishing between known and unknown quantities; choosing a mathematical model or formula; executing the algorithm; checking the result; expressing the answer in context. This structure is consistent with Polya's principle of "understanding - planning - doing - reviewing". In this case, the modern metacognitive approach also requires the student to monitor his or her own thinking process.

In the first stage, the questions "What is known?", "What needs to be found?", "Which quantities are related?" are asked. In the second stage, a suitable formula or model is selected. In the third stage, the calculation is performed. The fourth stage is devoted to verification, where the units, signs, logical magnitude of numbers and their correspondence to the content of the problem are checked. Finally, the answer is written not as a simple number, but as a meaningful expression of the quantity asked in the problem.



The first method is question-based management. The teacher does not provide a ready-made solution, but encourages the student to explain the next step. The second method is to compare two or more solutions to a problem. Such a comparison allows the student to see the differences between the methods and choose the most appropriate strategy for the situation. 5,6 The third method is error analysis. Finding the error in the wrong solution, explaining its cause, and justifying the correct solution enhances reflective thinking.

The fourth method is to formulate a reverse problem. For example, developing a condition that leads to an answer helps the student understand the two-way nature of mathematical relationships. The fifth method is to change parameters. It analyzes which steps remain the same and which change when the numbers, units, or context change. Foster's research also shows the importance of explicitly teaching content-specific tactics in addition to general strategies in solving mathematical problems. {8}

Incrementally complicating standard problems is also effective. First, a simple problem with a complete conditional, then a task with a hidden connection, and then a task with additional information or with several solutions can be given. This sequence takes the student from mastering the algorithm to analyzing the mathematical situation. The scientific literature on mathematical competence also considers the unity of understanding, fluency, strategic competence and flexibility to be important. 9,10

Mathematical literacy is not limited to calculation itself. The student must mathematically represent a real situation, select an appropriate model, interpret the result and evaluate its content validity. 3 From this point of view, standard problems can be an initial “training ground” for mathematical literacy. For example, giving a task on interest in the context of a discount or a family budget forces the student to relate the result to a real-life situation.



From the analysis of scientific sources and methodological approaches, it becomes clear that the educational value of a standard problem depends not so much on its “easy” or “difficult” nature as on the kind of thinking activity it requires from the student. Repeating the same algorithm in a fixed form may increase procedural fluency, but it is unlikely to sufficiently develop the flexibility of knowledge. On the contrary, presenting the same mathematical structure in different contexts, graphs, tables, and question forms encourages the student to move from superficial symbols to abstract mathematical relationships. The discussion process also shows that the boundary between standard and non-standard problems is not absolute. If a combination that is new to the student initially seems non-standard, it can become standard as the necessary basic knowledge is formed. Thus, standard problems are not the opposite of non-standard problems, but rather a structural basis that prepares them. The student first confidently masters mathematical operations and basic models, and then proceeds to reorganize them in new situations.

Another important result is that comparing multiple solutions in class broadens the student’s narrow view of “one correct algorithm.” In the experiments of Rittle-Johnson and Star, such comparisons had a positive effect on procedural knowledge and flexibility. Therefore, it is advisable to regularly use questions such as “which method is the fastest?”, “which method is more understandable?”, “which method is easier to transfer to another situation?” when teaching standard problems.

CONCLUSION

Based on the theoretical analysis, the didactic potential of standard problems in the mathematics course was characterized by several scientifically significant results. First, standard problems are a supporting tool for transforming mathematical knowledge into practical activity, forming the ability to consciously apply formulas, rules and algorithms. Second, their effectiveness depends not on the number of tasks, but on the content diversity, consistency and conscious organization of the solution process. Third, the consistent use of the stages of problem solving: understanding,



model building, execution, verification and reflection strengthens metacognitive control.

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