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### **Word problems in the school mathematics course**

Kudaibergen A.A. Master student

Suleyman Demirel University

### **Abstract**

Mathematical education is part of the system of continuing education and is of great importance in ensuring the development of human intellectual abilities in modern society. In the secondary education system, teaching mathematics takes a special place in the development of cognitive abilities and logical thinking of students. The main goal of our study is to develop methodological foundations for teaching word problems in the process of teaching mathematics in secondary school and to test its effectiveness experimentally. There are various methods for solving word problems: arithmetic method, algebraic method, geometric method, logical method, practical method, and tabular method. Different mathematical models are created based on each method. In the course of secondary school mathematics, two methods of solving word problems are considered: arithmetic and algebraic. The main purpose of the conducted pedagogical experiment was to test the effectiveness of the method that allows to increase the level of mathematical training of secondary school students, based on the use of the algebraic method in solving word problems of secondary school students. Prospects for research on the development of teaching methods for solving word problems are associated with a deep consideration of professional, creative and personal aspects of students.

**Keywords:** teaching to solve word problems, word problem, structure of word problem, algebraic method.

The main directions of modernization of the country's education system in accordance with modern requirements are clearly reflected in the state program for the development of education and science of the Republic of Kazakhstan for 2016-2019. Its main task is to improve the quality of education and increase the competitiveness of the national education system. Therefore, the need to improve teaching methods and further improve the effectiveness of training students is obvious. [1]The state mandatory standard of education of the Republic of Kazakhstan defines the task to consider: "a student who has certain necessary skills and abilities, a subject of educational activity, an author who, from the point of view of his attitude, acts in a dialogue with different cultures and a child who works in accordance with age characteristics, making efforts to form his path"[2]. For this reason, the goal of this task is the education of children, which is currently considered one-sided and insufficient. Because if the school is not satisfied with education and does not teach how to apply this knowledge in practice, it would not be enough. Therefore, the study of various methods of solving word problems is one of the important and responsible tasks. Mathematical education is part of the system of continuing education and is of great importance in ensuring the development of human intellectual abilities in modern society. In the secondary education system, teaching mathematics takes a special place in the development of cognitive abilities and logical thinking of students. When solving word problems, the text plays a special role in the further enrichment and deployment of methods and techniques, the formulation of individual situations associated with it, the formation of cognitive abilities, and the independent development of mathematical thinking. This indicates the relevance of our topic. The main goal of our study is to develop methodological foundations for

teaching word problems in the process of teaching mathematics in secondary school and to test its effectiveness experimentally. Based on this goal, we set the following tasks:

- Determination of the role and significance of word problems as a means of developing students' thinking in the process of teaching mathematics, methodological foundations of teaching word problem solving;

- Development of methods for organizing students' learning to solve word problems;

- Development of teaching methods for solving word problems in the course of algebra;

- Experimental testing of the effectiveness and development of teaching methods for solving word problems in secondary school.

The choice of the research topic due to the need for further development of educational theory and practice of teaching students to solve word problems, there are conflicts between requirements qualifications and specific results, as well as insufficient development of methodical bases of teaching of solving word problems by the updated content of education.

### **Literature review**

Numerous dissertation studies on the formation and development of mathematical knowledge of secondary school students have been conducted. In addition, the psychological, pedagogical, and methodological literature provides various aspects of the use of word problems in the process of teaching and educating students. The essence of word problems, their significance and functions in the educational process D. B. Bogoyavlensky, J. Bruner, V. V. Davydov, K. Dunker, A.V. Zaporozhets, V. P. Zinchenko, A. N. Leontiev, A.M. Matyushkina, V. A. Menchinskaya, L. Rubinstein, etc. Problems of improving methods of teaching word problem solving, defining and applying the role of word problems in teaching mathematics, etc. In the works of Bekboev, D. V. Klimenchenko, Y. M. Kolyagin, D. Poya, L. M. Fridman, V. I. Krupich,

P. M. Erdniev, B. P. Esipov, I. Ya. Lerner, A.V. Usova. The problems of teaching the development of mathematical education in Kazakhstan, activating the mental activity of students and solving word problems that have become the theoretical basis for teaching mathematics, are considered in the works of methodologists: A. E. Abylkasymov, B. B. Baymukhanov, M. E. Esmukhan, A. K. Kagazbayeva, A.M. Mubarakov, L. U. Zhadraeva, E. M. Smagulov, L. T. Iskakova, etc. [3-5].

### **Methods of solving word problems<sup>1</sup>**

In most cases, the main focus of students and teachers will be on finding answers to the question asked in the report. Thus, the following important questions of teaching students to find solutions to word problems are not taken into account: how to find ways to solve word problems independently, what to do for this, what ways and methods to find solutions to word problems?

There are various methods for solving word problems: arithmetic, algebraic, geometric, logical, practical, and tabular. Different mathematical models are created based on each method.

*The arithmetic method* is to find by performing arithmetic operations to numbers in accordance with the terms of the settlement. In most cases, you can output a single report using various arithmetic methods.

*The algebraic method* - solving and constructing a system of equations (inequalities) or equations (inequalities) in accordance with the requirements of the problem agreement. One problem can be derived in various algebraic ways.

*The geometric method* - finding geometric inserts or properties of geometric shapes in accordance with the requirements of the problem agreement using the similarity of triangles, the area of the shapes, and so on.

*The logical method* is to find logical thinking without performing the calculation in accordance with the conditions of the problem.

*The practical method* is found by performing practical actions with items or their copies (models, layouts) in accordance with the report conditions.

*The table method*, you can find the content of the report that meets the report requirements by entering it in the compiled table, respectively. It allows you to view the entire report [6].

In the dissertation work Bilyalova Zh. T. focuses on the use of arithmetic methods for solving mathematical word problems in the formation of concepts and concepts in the study of theoretical materials in primary school [7].

As given in the secondary school math curriculum [8]. In the course of secondary school mathematics, two methods of solving word problems are considered: arithmetic and algebraic. The arithmetic approach consists of searching for the value of an unknown quantity by creating a numeric expression and calculating the result. The algebraic approach is based on the use of a system of equations and equations created when solving word problems.

***Example.***

At 8 am from point A to point B left the train at a speed of 60 km/h. At 11 h from point B to meet him came another train at a speed of 70 km/h. At what time the train will meet, if the distance between points 440 km.

*Table 1*

Solving by two methods

Algebraic method	Arithmetic method
Let $x$ h — time of movement of the second train to a meeting. By the condition of the problem we obtain: $(60 + 70) \cdot x + 60 \cdot 3 = 440$ , or $130 \cdot x + 180 = 440$ Transform the equation; $130 \cdot x = 440 - 180$ ; $130 \cdot x = 260$ Find the unknown:	Find the sum of the train speeds $(60 + 70) = 130$ ; the time of the first train before the start of the second $(11 - 8 = 3)$ ; the distance traveled by the first by train for 3h $(60 \cdot 3 = 180)$ Find the distance that remained armhole trains to the meeting: $440 - 180 = 260$ (km) Find the time of motion of the

Algebraic method	Arithmetic method
$x = 260:130; x = 2$	second train: $(260:130 = 2) (h)$

Answer: the trains will meet at 13: 00.

In this regard, in this study, word problems that are rendered in an algebraic way are called word-based algebraic problems. Thus, we offer a sequence of stages for solving a problem when teaching students to solve word problems and how to write it:

- selecting an unknown quantity and marking it with a letter;
- the embossing of the remaining symbols with this letter;
- creating an equation;
- solution of equation;
- answer to the report question;
- checking the received solution and response according to the report conditions.

In the psychological-pedagogical and scientific-methodical literature, much attention is paid to the issues of teaching methods for solving word problems using the algebraic method. The problem of teaching students to solve word problems using the algebraic method became relevant more than two centuries ago and is now. The first attempts to give general rules for solving word problems using the method of composing equations go back to the works of R.Descartes and I.Newton, in which the authors recommend that all unknowns in the word problem be marked with letters, and then the problem condition be translated into algebraic language by composing the equation [9], [10]. It should be noted that the works of R.Descartes and I.Newton, in general, gave an impetus to the development and use of the algebraic method in solving word problems. Later, many prominent mathematicians and methodists addressed this problem. Questions of teaching students to solve word problems using the algebraic method are reflected in the works of B. I. Alexandrov, A. N. Barsukov, E. S. Berezanskaya, E. Bezu, V. A.

Gusev, F. N. Ziganshin, Yu. M. Kolyagin, V. I. Krupich, E. I. Lyashenko, A. G. Mordkovich, F. A. Orekhov, D. Poya, A. A. Stolyar, E. N. Turk, L. M. Friedman and many others. In their works, the authors reveal the essence of the algebraic method and give detailed recommendations for its application to solving various problems, including textual ones.

*Pedagogical Experiment.*

The main purpose of the conducted pedagogical experiment was to test the effectiveness of the method that allows to increase the level of mathematical training of secondary school students, based on the use of the algebraic method in solving word problems of secondary school students. Experimental work was conducted from 2018 to 2020 in grades 7-8. In total, 72 students took part in the experiment. The work was carried out in three stages.

Defining experiment (2018 y.);

Formatting experiment (2019 y.);

Concluding experiment (2019 - 2020 y.).

The main aim of Defining experiment: determination of mechanisms for improving the quality of knowledge in solving word problems, checking the level of students' knowledge of ways to solve problems, identifying the use of effective and ineffective ways to solve word problems. The main research methods at this stage: control of algebra lessons in grades 7-8, interviews of teachers and students on the formation of educational activities, transfer of independent work of students, analysis of control notebooks and work of students, questionnaires of students and teachers, analysis of educational programs and textbooks in algebra for grades 7-8. At the first stage, we participated in an algebra class in grades 7-8. The survey results showed that 70% of students in grades 7-8 know that reports consist of two parts: a contract and a question. 82% of students show that the way to understand the report conditions will help you

write a summary of the report condition: example, drawing, oral and tabular. Most students know the oral, action and methods of constructing equations that form the solution of problems. And only a small part of students showed ways to find a solution to the word problem, so they determined ways to find a solution to the word problem through individual actions of students: the ability to highlight the main attitude to the report, model the main attitude, and search for a solution to the word problem.

The main aim of Formatting experiment – determining the knowledge, skills and abilities needed to form when solving word problems for students in grades 7-8. In the course of this experiment were adjusted for educational activity, system requirements, word problems, checked the work of students, emerging in the course of independent work, identifies effective and ineffective ways of solving word problems.

At the third stage of the study, a Concluding experiment was conducted. The results of exams of experimental and control groups of grades 7 and 8 are presented in the tables.

Table 2

The results of control work of experimental and control groups of class 7.

Actions	Control groups	Experimental groups
Search methods completed	59%	75%
The equation is formed correctly	70%	81%
The report was released correctly	68%	77%

The exam results show that the performance of students of experimental group significantly higher than students in the control group.

Table 3

The results of control work of experimental and control groups of class 8.

Actions	Control groups	Experimental groups
Search methods completed	61%	82%
The equation is formed correctly	75%	85%
The report was released correctly	69%	80%

The exam results show that the performance of students of experimental group significantly higher than students in the control group.

From the processed data on the updated content of education in secondary schools, the effectiveness of methods of organizing students' activities to solve word problems in mathematics lessons and methods of teaching them, the correctness of the application of methodological instructions and the system of level tasks was clarified.

The types of word problems in the school algebra course were determined, and a method of teaching their solution was proposed, the effectiveness of which was experimentally tested and proved.

Prospects for research on the development of teaching methods for solving word problems are associated with a deep consideration of professional, creative and personal aspects of students.

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## Tables

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