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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

LOGICAL PROBLEMS IN MATHEMATICS AS A MEANS OF IMPROVING THE QUALITY OF LEARNING IN ELEMENTARY SCHOOL

Specialty:	5801.01 – Theory and methodology of teaching and education (methodology of teaching mathematics)
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GENERAL CHARACTERISTIC OF THE RESEARCH

The relevance and usage degree of the research. Improving the education system, content and methods of education, in accordance with international practice, are the important tasks facing schools and teachers. Mathematical training, as well as the solution of logical problems, plays an important role in implementing the task of improving the education system. This being said, logical problem solving in math classes forms reasoning and thinking habits in students. In this regard, the well-known methodologist prof. A.A.Stolyar wrote: *"The main task of math is to teach children to think from the first grade."*[1] Every teacher must develop students' mathematical and logical thinking. There are important requirements in the methodological literature and mathematics programs. However, in secondary school practice, the teacher does not always know at the required level how to develop students' ability to think logically about logical laws, as the system of methodological work with logical problems is not at the required level. This often leads to the spontaneous development of mathematical logical thinking, so most students, even high school students, do not master the techniques of logical thinking, such as analysis, synthesis, comparison, abstraction, and so on.

The reason why mathematics is so important in the development of logical thinking is that it is the most theoretical science among all the subjects studied in school and has a high level of abstraction in mathematics and the existence and application of a method of transition from abstract to concrete in the most natural way. As pedagogical experiment and experiments show, one of the most effective ways to develop mathematical thinking in primary school students is to consistently solve non-standard logical problems for them. Solving non-standard logical problems helps to create great interest in students' learning of mathematics.

The outstanding educator V.A. Sukhomlinski gave importance

[1] *Stolyar, A.A. How math puts the mind in order / A.A. Stolyar, - Minsk: Higher school, 2nd edition, - 1991.*

to the issue of teaching logical problems to young children. The essence of his thinking is to teach and analyze the process of children's solving logical problems skills, when he has experimentally discovered the peculiarities of children's imagination.

The problem of using logical problems in mathematics training was highly appreciated by academician A.N. Kolmogorov, professor A.A.Stolyar and D.Poya. Methodist scientists F.F.Nagibin, V.A.Kordemsky, T.K.Jikalkina, M.I.Moro, M.S.Akbarov, N.R.Abbasov, H.Sh.Alizade, Z.F.Kazimov, F.F.Mustafayeva, A.A.Karimova, S.S.Hamidov, A.S.Adigozalov and others wrote textbooks or methodological aids related to the problem, put forward valuable methodological ideas on improving the quality of teaching mathematics using logical problems in primary school mathematics lessons.

The German philosopher I. Kant has commented about logic as follows: "Logic is the science of the laws of reason, of the requirements for consistent and reasonable judgment."

It follows that in training we must teach students to analyze, compare, distinguish, generalize and systematize the main ones, to prove and deny, to define and explain concepts, to pose a problem and to solve it. Mastering these methods makes it important to develop consistent and sound judgment skills. It is impossible to form logical thinking without logical learning. In some cases, students act intuitively, citing intelligence, life experience, and adult instruction.

The facts we have commented on have been the basis for research on "Logical problems in mathematics in primary school as a means of improving the quality of learning."

The dissertation was prepared at the Department of Pedagogy and Methodology of Education of Ganja State University.

First of all, the mathematics standards, textbooks and teaching aids for primary school teachers were analyzed. Then the analysis of the psychological, pedagogical and methodical literature on the problem was carried out, and the teachers of advanced primary school teachers (Gulara Guliyeva, teacher of secondary school №39 named after M.C. Pashayev in Ganja, teacher of secondary school

№4 named after A. Javad in Shamkir city, GaranfilAskerova, Ganja secondary school №9 teacher SaadatIbrahimova and others) were studied and summarized.

The methodological basis of the research is the theory of dialectical cognition, a set of principles, methods and theoretical provisions used to study, understand and change pedagogical facts, events and processes.

The object of research is the process of solving logical problems in the teaching of mathematics in primary school.

The subject of research is the forms and ways of using logical problems in the teaching of mathematics in primary school.

The aim of the research is to develop a methodological system for solving logical problems, identifying the need to use logical problems in order to improve the quality of mathematics teaching in primary school.

Research objectives are mentioned below:

- to determine the psychological, pedagogical and methodological bases of using logical
- to define the content and tasks of logical problems in mathematics lessons;
- to reveal the essence of non-standard textual logic problems, to analyze their role and importance in the development of logical thinking of younger students;
- to develop a classification of logical problems and to apply the methodical system of teaching elementary methods of mathematics in their mathematical lessons;
- to develop forms of organization of these lessons and methods of conducting them in accordance with modern requirements;
- to check the effectiveness of the teaching methods developed in the dissertation with the help of a pedagogical experiment.

Research methods: The research methods that were used in the dissertation are observation, questionnaire survey, comparison, generalization, study of school documents and advanced school experience, analysis of psychological, pedagogical and methodological literature and pedagogical experiments.

Claims of the defense:

- the use of logical problems in mathematics lessons in elementary school creates ample opportunities for the development of logical thinking and intellectual abilities of students;
- the introduction of a system of logical problems and the technology of their use in teaching mathematics in the educational process encourages students to research, activates their logical thinking, and develops the skills of analysis, finding solutions and conclusions;
- the use of a system of logical problems aimed at the development of intelligence and critical logical thinking in younger students helps to improve learning outcomes in mathematics and the formation of lines of action, increases interest in mathematics and helps to realize the developmental function of the elementary course in mathematics.

The scientific novelty of the research is to assist teachers in the study of theoretical and practical aspects of activating cognitive activity, enhancing intellectual abilities, and developing students' ability to solve non-standard logic problems through the solution of logical tasks in elementary school mathematics, as well as the development of a methodical system that will directly assist teachers.

The theoretical significance of the research lies in the fact that the inclusion of the solution of logical problems in the educational process of mathematics in elementary school motivates students to research, activates their mental thinking, develops analytical skills and the ability to draw conclusions;

- research methods and methodological approaches to the problem of improving the quality of mastering mathematics by primary schoolchildren by solving logical problems aimed at developing critical thinking and intelligence have been developed. This will be a great opportunity to enrich the science of teaching mathematics with new statements.

The practical significance of the research lies in the fact that a system of logical problems and technologies of their use have been

developed, which make it possible to increase the logical thinking and intellectual abilities of younger students in mathematics lessons. The system of logical problems presented in the dissertation and the methodology for solving them will provide practical assistance to mathematics teachers in the future, can be successfully used in improving the teaching of mathematics, compiling textbooks and teaching aids in mathematics, guidelines and recommendations for teachers.

Research hypothesis: If:

- correctly defined functions, place and possibilities of logical problems in mathematics teaching process;
- ways, forms and means of using logical tasks in the teaching of mathematics in elementary grades are well defined;
- non-standard logical problem solving methodologies are developed to meet the requirements of active learning, then they are:
- helps develop the skills of logical problem solving and increase the level of mastering in elementary school students;
- promotes the development of logical thinking and creative abilities of junior students;
- increases the interest in learning math in children, enhances their ability to apply theoretical knowledge into practice, eliminates the formalism in knowledge, forms the correct scientific knowledge, and promotes overall development.[2]

1. **Approbation of the research.** The general provisions of the dissertation were regularly reported at the Department of Pedagogy and Teaching Methods of GSU.

Structure of the dissertation: The dissertation consists of a title, table of contents, introduction, the content of the dissertation , a conclusion , a list of references and additions.

[2] *Zeynalova, I.Z. Requirement for using logical problems in teaching mathematics at school // – Saransk: University experiment in image. The scientific - methodical journal – 2019. №3 (91) (July-September), – p. 82-86*

THE MAIN CONTENT OF THE RESEARCH

The introduction is justified by the relevance of the research, the aims and objectives of the study, the object and the subject, the hypothesis and the defensive clauses, the scientific novelty of the case, the level of study, theoretical and practical significance of the dissertation.

Chapter I is entitled **"Scientific and Methodological Basics of Using Logical Problems in Mathematics in Primary Schools."**

In the first subchapter, **"The essence of the concept of logical problem, its place and importance in mathematics training"** is explained.

It is noted that the teacher now has a task not only to equip his students with conscious and solid knowledge, but also to teach them to learn independently. The teacher's job is to instill in his students hard-working, independent, creative work habits, and to develop skills in overcoming challenges.

Solution of logical tasks and activities stimulates student's thinking, activates mental activity and stimulates learning process. They are used both in training and in daily life.

A logical problem is often understood to mean that issues are solved only through logical operations. Logical problems help to develop the skills of judging correctly. Solving such problems teaches students to think through unfamiliar situations to the end, not to retreat out of fear of difficulties, to overcome them, and increases students' self-confidence.

Logical problems have high potential. They help students develop critical thinking, which is one of the most important qualities of thinking, teach them to analyze the perceived information, its comprehensive assessment, and increase interest in mathematics lessons.

Another feature of logical problems is that they contribute to the development of reasoning operations, properties of thinking, far beyond standard problems.

The second subchapter is dedicated to **"Psychological-pedagogical principles of development of logical thinking in**

young schoolchildren."

Logical thinking is one of the types of thinking that enables the student to analyze, compare and evaluate objects, situations, events. The process of logical thinking is formed through various operations that move from one to another.

Logical thinking is, first of all, correct thinking, thinking that conforms to the laws and rules of logical science. It must be borne in mind that the practical ability to master the laws and forms of thinking by students is acquired not only as a result of studying the science of logic, but also as a result of their regularly repeated personal experiences and habits.

When working on logical thinking, it is very helpful to consider the age opportunities of the students. Only students can develop their thinking on the material they understand.

In elementary grades, it is necessary not only to convey the basics of knowledge to students, but also to teach them to think independently and work creatively.

Logical and psychological studies of recent years (especially the work of I. Piaget) determined the mechanisms of connection between the thinking of younger schoolchildren and general mathematical and general logical concepts.

The development of thinking occurs in the following three forms: visual and practical (3-4 years); visually (5-6 years) and Verbal (7-10 years). Elementary school plays a key role in the development of age thinking.

The ability of elementary school students to think logically, analyze, compare and summarize the necessary information helps them master subjects such as informatics and mathematics.This allows you to solve both ordinary and entertaining logical problems accurately and quickly, and has a positive effect on students' cognitive performance in general.

The third subchapter presents **"Species of Mathematical Problems and Some Specifics for Solution of Logical Problems in Primary School".**

When teaching mathematics to younger students, great importance is attached to text problems, which are an important

means of forming basic mathematical concepts.

Problem solving skills are an integral part of the program as one of the most important training objectives. At present, not only the system of mathematical problems has changed significantly, but also the functions they perform. Many problems do not only have didactic functions, but also cognitive and developmental functions. In books, we also come across problems that do not have a specific solution algorithm, but require creative, non-specific approaches. Such problems are called non-standard. Non-standard tasks are those tasks that do not have general rules and regulations that determine the exact program for solving them in a mathematics course. Non-standard tasks are always characterized by multiple answers and solutions. However, they cannot be equated with tasks of increased complexity. The state of problems of increased difficulty is such that it is possible to find a mathematical apparatus for solving them. Non-standard problems are of a research nature, and it is impossible to find a mathematical apparatus for their solution. Non-standard problems are used in various forms and in extracurricular activities in mathematics lessons in elementary school. Interesting texts of these problems provide an opportunity to increase motivation during the lesson.

The standard problems are that there are ready-made rules in the school math course for solving them, and these are derived directly from any definition or theorem.

The fourth paragraph called **"Logical Problems in Primary Mathematics as a Developmental Learning Tool,"** states that human intelligence is determined not by the accumulation of acquired knowledge, but by the ability to use it, that is, by logical thinking. Therefore, it is necessary to form and develop the logical thinking of students through solving interesting, entertaining, logical tasks in the elementary grades.

Regular use of problems with different ways of expression, form and content during the lesson and in independent work expands the worldview of students and develops their mathematical thinking.

It is the solution of logical problems that develops mathematical thinking, not only to better master the mathematics, but

also to successfully study any other science.

Chapter II is entitled **"Ways and Forms of Using Elementary Elements in Logical Problems in Mathematics."**

First subchapter called **"Classification of Logical Problems and Forms of Methodical Work on them in Mathematics"** presents the classification of logical problems for elementary school students is as follows:

1. Logical problems about relationships.
2. Problems related to "crossing the water".
3. Problems about "Liars".
4. Think and calculate! Thought-provoking problems;
5. Logical problems solved with the help of stencils and graphs.
6. Logical problems solved with the help of schemes and schedules.
7. Logical game problems.
8. Logical problems on fluid transfusion.

From a mathematical point of view, problems are divided into the following types:

- Problems related to determining the validity of judgments;
- Problems in which logical relationships are used;
- Problems with quantum utilization;
- Problems related to the formation of simple judgments.

All logical problems can be divided into two groups according to their mathematical content:

- Problems that are using numbers and digits;
- Problems that are not using numbers and digits.

The solution of logical problems is interesting and entertaining. They make the student's lesson more colorful, allow the student to find his or her own solutions to the problem, and most importantly, teach them creative and non-standard thinking.

In order for students to acquire the proper knowledge, skills and abilities in solving logical problems, it is important to fulfill the following methodological requirements:

- Logical problems for solving in elementary grades must be chosen in full accordance with the program related to the

basic course of mathematics;

- In mathematics lessons, one should correctly determine the place of a logical problem and its time;
- Prepared logical tasks must fully correspond to the level of mathematical knowledge of students;
- To increase the interest of elementary school students in solving logical problems, the content of the selected mathematical problems should be as colorful and interesting as possible;
- Mathematical judgments should be effectively and widely used in solving logical problems.
- The purpose of the logical question should be clearly, succinctly and accurately stated;
- The question of the logical problem should be taken from its content by being specific, precise and clear;
- The teacher should pay special attention to the control of students' knowledge on logical problems;
- Checking the solution of logical problems should never be delayed by the teacher;
- When evaluating the solution of logical problems, the teacher must correctly observe the norms of grading;
- In the process of solving logical problems, the knowledge, skills and abilities acquired by students in mathematics lessons should help their independent activities in the classroom and at home.

In the second subchapter **"Teaching Methods for Solving Logical Problems in Relationships"** are shown.

A necessary condition for solving logical problems on relationships in is the ability to move from one relationship to another between the elements of a problem. For example, if we come across a light and heavy relationship in a given mathematical problem, then by making the appropriate displacement, we create only a heavy (light) relationship between the elements given in the problem by replacing the light relationship with a heavy one (or vice versa).

To solve the problem, it is necessary to be able to model it with the help of the scheme, that is, to illustrate the terms of the problem in words as model-illustrations. The solution to this problem must begin with a review of the model-illustration.

Subchapter three explains **"Teaching Methods for Solution of Logical Problems Using Schemes and Tables".**

While solving problems using schemes students briefly write down the condition and question of the matter, express the elements of the condition of the problem with symbolic variables, and then begin to solve the problem. If there is coherence between the two elements, then these elements are combined with a complete line, and if there is no conformity, then they are combined with a broken line.

It is useful to solve such problems with the help of a table, when a large number of elements are given in the issue, the application of the scheme is inadequate, and the space is too high.

The table is a traditional solution not only to solve the logical problem but also to find the optimal solution. The table allows you to explain the condition of the issue, and whether there is any excess or missing data.

The fourth subchapter called **"The methods of solving "Crossing water" problems"** explains the difficulty in these problems is the limited capacity of the floating vehicles (boats, rafts, etc.) provided by the conditions and the nature of the passengers. To record the process of these problems, the schematic description of rivers, beaches and floating means is described, each stage of the crossing is separated by a horizontal line, and an arrow is drawn to indicate the direction of the floating vehicle. Writing a problem-based scheme can help children better understand the content of the problem and, more importantly, understand the course of the trial.

Subchapter five provides **a methodology of solving problems about "liars".**

Problems of this type are defined by the following principle: one, two, or three groups of people are given. Representatives of one of the groups tell only truth, while other representatives tell only lies; the representatives of the third group can tell both true and false.

The sixth subchapter is called **"Think and calculate!" solution of thought-provoking logical problems.**

These types of problems are usually puzzling and require simple calculations to solve them. The solution of such problems requires special attention. Students realize that the solution to the problem sometimes depends on the small amount of nuance given.

"Techniques for solving logical problems related to the liquid emission", given in the seventh paragraph, are of practical importance, in everyday life, in the process of working in various fields, and etc. The setting of such logical problems in extracurricular conditions, for example, during a field trip to a farm, makes students believe that problem solving may be necessary in any life situation.

Therefore, special attention is given to the classification of such problems and the study of ways of their solution.

The eighth subchapter is entitled **"Methods for the Study of Logical Problems Using Stencils and Charts."**

It has been shown that these problems can teach children to assess the situation and to make the right decisions. In matters addressed with the stencil, the teacher first reads the text of the issue, and the students solve it by writing the necessary notes on the ready stencil. In order to get the answer, it is necessary to combine the signs of concepts that are compatible with them. The correct answer is shown by the teacher. After getting used to certain habits, the students independently create their own stencils and solve the problem.

In mathematics, it is preferable to apply a graph for solving the problem in several ways. It is advisable to teach the children how to solve the problem with ready charts first, then to complete the chart and then proceed with the tasks of its independent construction.

Subchapter nine describes several types of logical problems under the heading **"Logical game problems" and explains their methods.**[3]

Mathematical tricks. The solution of logical problems is

[3] *Zeynalova, I.Z. Logical game problems and their solution // – Ganja: Ganja State University. Scientific news, – 2019.№2, – p.271-275.*

subject to strict mathematical laws. However, there are problems where the nature of their solution is the same for all units that pay. Therefore, when the teacher gives an answer in advance, the students are surprised and admired by the teacher's knowledge.

In the process of solving **logical problems using match** students have the ability to build geometric shapes and learn to apply their mathematical knowledge and skills to specific figures.

Numerical and alphanumeric rebuses. The expression given in the rebus is indicated by certain symbols (letters, triangles, squares, circles, etc.). These symbols represent any number from 0 to 9. The same letters indicate the same numbers. In the rebus, the first digit cannot be “0”. Solving the rebus means replacing the signs there with the corresponding figures. The solution of the rebuses requires logical thinking and careful thinking. Mathematical rebuses are widely used at fun mathematical events, interest courses, olympiads and etc.

Magic figures. The solution of these types of tasks is to form and accelerate students' ability to perform verbal calculations. More elementary problems are addressed in elementary grades.

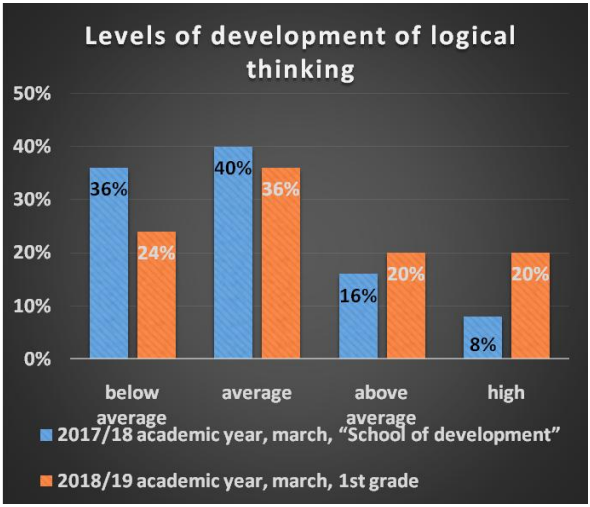
The paragraph **“Possibilities of using ICT in solving logical problems”** shows that it is very important from a methodological point of view to interest students in studying various subjects and learning outcomes in primary grades.

The organization of a lesson using information technology creates a strong incentive in learning. Multimedia presentations are a convenient and effective way of presenting various information using computer technology.

Mathematics lessons conducted with the help of ICT have several advantages. The use of ICT in the primary school classroom enables the classroom to maintain a high aesthetic level and extends the scope of the textbook, facilitates the work of the teacher and gives children a clear idea of the problem and saves time. It is possible to present a large volume of information to students in a compact manner. Students independently read the tasks that appear on the screen, which activates their logical mathematical thinking activities. The image of the mathematical problem is being displayed

on the monitor very clearly, brightly and in motion. All these increase students' interest in the lesson.

We used the questionnaire of N.I.Derekleyeva to clarify the attitude of the first to the sessions used in the interactive board. 92% of the survey results show that students are eager to attend an interactive board. Only 8% of students are neutral.



Picture 1

Thus, the application of computer technologies helps to improve the quality of mathematical knowledge, leads to the general development of students, eliminates mathematical difficulties, creates favorable conditions for mutual understanding and cooperation between students and the teacher in the teaching process.

Organization of pedagogical experiment and analysis of the obtained results.

Our researches were investigated throughout the years of 2016-2019 and consist of a three-stage (experimental, educational and verifiable) pedagogical experiment.

The aim of the research at the initial stage is to determine the level of knowledge, skills and abilities of junior high school students in the process of learning mathematics in elementary school (while

doing oral and written tests); select schools, experimental (E) and control (K) classes; to ensure that students and teachers of mathematics teaching in these classes have equal knowledge and skills (questionnaire survey); to formulate and express the working hypothesis of the study. In the selection of experimental and control classes, it was expected that the number of students in those classes, their knowledge levels, professional skills and experience of teachers would be approximately the same.

In the process of pedagogical experiment, proposals, ideas and specific methods related to the content and teaching methodology of the methodical system proposed by the author were delivered to the teachers of the experimental classes, they were provided with the necessary materials. Although the teachers of the control classes were familiar with the purpose of the experiment, they did not have information about the content and methodology of the research.

The aim of the experimental learning phase which covered 2017-2018 was to develop a system of game-like logical problems to stimulate children's cognitive activity and to develop continuous thinking in elementary school mathematics lessons. Teaching solutions developing methodology for addressing deficiencies in children with problem solving skills, familiarizing the experimental classroom teachers with this content and methodology, conducting an experimental experiment on the new methodical system developed by the dissertator, defining the methodology of the experiment.

The purpose of the piloting experiment in 2018-2019 was to identify the overall mathematical development of children by developing and developing logical problem-solving skills in primary school students to demonstrate the effectiveness of the proposed method. Analysis of the results of the verification experiment shows that the proposed methodological system turned out to be quite efficient.

In our piloting and control classes, the total of 419 students participated in 206 experimental and 213 student control classes. Examination options include mathematical rebuses, labyrinths, tricks, interesting calculations, entertaining problems and etc. The issues addressed were consistent with the age and knowledge of the

children, and the didactic functions of the issues were taken into account.

The results obtained in the stages of the pedagogical experiment were analyzed by the mathematical-static method.

It was observed that the system of logical problems solved in the mathematics lessons of primary classes activates the cognitive activity of students and develops their logical thinking. In the training, students' interest in mathematics increases, and as a result, the quality of mathematics education increases. This confirms the correctness of the hypothesis of the study.

Examples:

1. Three containers with capacity of 8 liters, 5 liters and 3 liters the largest of which is filled with milk. How can you divide this milk by half using these containers?

2. Yunis, Pasha, and Samir participated in the race. Pasha never took first or second place. Samir came after Yunis. If the boys took different places, which of them took which place?

3. Three friends, Rashad, Aqil, and Jamal watch the movie in the cinema. What are the several ways they can sit side by side.

4. Add 1 to the number of family members, multiply by 2, and subtract 3, and tell the difference. I will also tell you the number of your family members.

5. Five matches were given. Using these matches, create five triangles of the same size

6. Qamar has four shirts of red, yellow, blue and light colors, and two skirts in blue and orange. How many options does she have to choose a set of these clothes? Complete the layout and color the lines according to the color of the clothes

7. Replace the digits in an arbitrary two-digit number that the second digit is not zero. Divide the sum of these two numbers by the sum of one of the numbers. The result will be 11. How does that happen? Explain.

8. Write down the first 15 numbers of the sequence of natural numbers using arithmetic symbols, and only the number 2 five times.

9. 1; 2; 3; 4; 5; 6; 7; 8; Write arithmetic symbols between the numbers 9 so that the value of the received expression is equal to

100.

10. There are pigeons and rabbits in the cage. All animals have 35 heads and 94 legs. How many pigeons and rabbits are there in the cage?

Let's briefly inform you about the results of our experiments.

a) The results of the deterministic experiment:

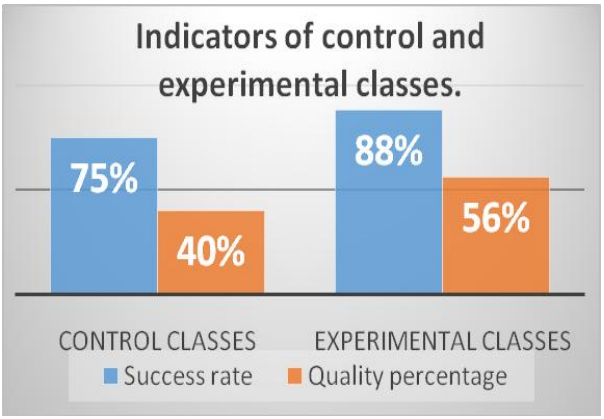
Table 1

Schools	Grades	Number of students	Mark				W_a	$\sum$	M_e	σ	*G*	*M-G*
			2	3	4	5						
Ganja secondary school №1	II_E	25	5	15	5	-	3	5	3,50	75	3,00	0,50
	II_k	26	5	16	5	-	3	5	3,50	70	2,69	0,81
	III_E	24	5	15	4	-	3	5	3,46	71	2,69	0,50
	III_k	25	5	15	4	1	3	5	3,50	76	3,04	0,46
Ganja secondary school №9	II_E	26	5	16	5	-	3	4	3,50	78	3,00	0,50
	II_k	26	4	16	5	1	3	4	3,56	81	3,12	0,44
	III_E	25	4	16	4	1	3	4	3,53	77	3,08	0,45
	III_k	23	4	13	6	-	3	6	3,58	71	2,88	0,49
Ganja secondary school №39	II_E	27	6	18	3	-	3	7	3,42	78	2,90	0,54
	II_k	29	7	18	4	-	3	5	3,42	84	3,00	0,52
	III_E	26	5	16	5	-	3	5	3,50	78	2,96	0,50
	III_k	27	5	15	5	1	3	7	3,50	80	2,89	0,54
Shamkir secondary school №4	II_E	28	7	17	4	-	3	7	3,41	81	3,04	0,52
	II_k	29	7	18	4	-	3	4	3,42	84	3,07	0,53
	III_E	25	4	16	5	-	3	5	3,53	76	3,00	0,49
	III_k	28	5	17	5	1	3	5	3,53	86	3,04	0,46

b) The results of the control experiment

Table 2

Schools	Grades	Number of students	Marks				W_a	$\sum$	F	M_e	σ	G	$M_e - G$
			2	3	4	5							
Ganja secondary school #1	II_E	25	3	8	13	1	4	8	13	4,32	87	3,48	0,84
	II_k	26	5	15	6	-	3	5	15	3,53	79	3,03	0,50
	III_E	24	2	7	13	2	4	7	13	4,38	87	3,62	0,76
	III_k	25	4	14	7	-	3	4	14	3,60	78	3,12	0,48
Ganja secondary school #9	II_E	26	3	9	13	1	4	9	13	4,30	90	3,45	0,85
	II_k	25	5	13	6	1	3	5	13	2,57	78	3,12	0,35
	III_E	25	8	14	1	4	4	8	14	4,32	89	3,56	0,76
	III_k	24	4	10	9	1	3	4	10	3,80	79	3,12	0,68
Ganja secondary school #39	II_E	27	3	8	16	-	4	8	16	4,31	94	3,91	0,40
	II_k	27	6	16	5	-	3	6	16	3,46	80	3,00	0,46
	III_E	26	2	7	16	1	4	7	16	4,57	94	3,61	0,76
	III_k	25	5	13	6	1	3	5	13	3,57	78	3,12	0,45
Shamkir secondary school #1	II_E	28	4	9	14	1	4	9	14	4,35	96	3,43	0,92
	II_k	24	4	11	8	1	3	4	11	3,72	70	2,91	0,81
	III_E	25	2	6	15	2	4	6	15	4,43	92	3,68	0,75
	III_k	22	3	10	8	1	3	3	10	3,80	73	3,31	0,49



Picture 2

The results of the research have led to the following **conclusions**:

1. Certain changes have been made in mathematics teaching in terms of curriculum reform. The system of problems taught in the mathematics course of primary school and their functions have changed: problems, besides didactic functions, perform cognitive and developmental functions. That is why we often find in the textbooks that do not have specific solution algorithms but require a creative and non-ordinal approach. One of the most important universal cognitive operations for students is the creative solution of problems and issues, the ability to use knowledge in a given situation.

2. Formation of the ability to apply mathematical knowledge in the process of carrying out quite similar types of work is a prerequisite for mastering that knowledge. The opposite is also the case with the assimilation of the acquired knowledge. This complicates their application in only slightly different contexts, but also makes it difficult to understand the perspectives of both cognitive and developmental consequences of training. In this case, the impact on a student's abilities, wishes, and aspirations will depend little on the purposeful activity of the teacher.

3. Logical problems enrich and complicate the mathematical experience of younger students, activate their research activities, and

increase their interest in mathematics. Creating a motivated choice situation helps students to concentrate their energies and energies on the search for new cognitive methods, and achieve the learning outcomes of state standards in primary education.

4. The linking of intellectual activities with intellectual activity in the process of solving logical problems has a positive impact on the development of emotional culture in children.

5. In elementary school math lessons, logical and entertaining work on the choice of rational problem solving, mathematical and logical reasoning, and the design of various geometric shapes is a gift for children's creative abilities.

6. In elementary grades collective and individual teamwork, collaborative work, paper preparation and other collaborative work in math classes and extracurricular activities and other teamwork activities form the cooperation of children and respect for their teammates.

7. The use of logical work in the classes where children are not interested in math, who think math is a boring and dry science, can lead to higher results, improving the efficiency and quality of training.

8. The use of logical problems in elementary school mathematics in terms of entertaining living situations increases the intensity of teaching activities for younger students and provides them with an opportunity to provide free access to math instruction in the middle and higher grades.

9. The solution of logical problems based on the numerical materials collected in primary school math lessons and extracurricular activities helps understand the role of mathematics in life.

10. The results of the pedagogical experiment in schools have shown that the solution of logical problems in elementary school math classes can substantially improve the efficiency and quality of students' knowledge and skills, and has a positive effect on the need for cognitive learning in children.

11. The proposed classification of logical problems and the ways to solve problems according to this classification have become important and methodologically justified as a means to improve the

quality of learning in elementary school mathematics.

12. It has been established that the use of these or other types of logical problems as a means of improving the quality of primary school learning in math depends on the learning environment, the content of the learning material, and the purpose of the training.

13. It has been observed that many students who are not active in math classes and who do not show very high results in the solution of the problem are more interested in the course of logical problem solving and are more active in solving such issues, reflecting various life situations.

The pedagogical experiment demonstrated the validity of our hypothesis about the solution of logical problems in elementary school mathematics lessons and showed the effectiveness of the research. It gives us hope that in the future, the results of research will be used in the process of teaching elementary school mathematics.

In connection with the content of the dissertation, the following articles were published in periodicals recommended by the HAC, reports were made at international and republican scientific and methodological conferences:

1. Zeynalova, I.Z. Logical elements in the didactics of mathematics // – Baku: Institute of Educational Problems of the Republic of Azerbaijan, Scientific publications, –2016. №4, – p. 330-332.

2. Zeynalova, I.Z. The use of logical elements in elementary school mathematics training // The Republican Scientific Conference "Quality Assurance in Higher Education". – Lankaran: Lankaran State University. –23-24 December, – 2016, – p. 247–248.

3. Zeynalova, I.Z. Logical elements in the teaching of mathematics // II International Scientific Conference of Young Scientists. – Ganja: Ganja State University, – 26-27 October – 2017, – p. 396–397.

4. Zeynalova, I.Z. Features of development games and logical exercises in teaching mathematics // I.Z. Zeynalova, A.A. Karimova, – Baku: Journal of Preschool and Primary Education, – 2018. №2, – p. 42-46.

5. Zeynalova, I.Z. Methods of classification and solution of logical problems in elementary school mathematics // The XXII Republican scientific conference of doctoral students and young researchers, –Baku: Azerbaijan State Pedagogical University, – November 22-23, – 2018, – p. 44-46.

6. Zeynalova, I.Z. Opportunities for the use of ICT in the solution of logical problems in elementary school mathematics //– Baku: Institute of Education. Publications, – 2019. Vol. 86, №3, – p.218-221.

7. Zeynalova, I.Z. Logical game problems and their solution //– Ganja: GSU. SCIENTIFIC NEWS, – 2019. №2, – p.271-275.

8. Zeynalova, I.Z. Mathematical and logical development of primary schoolchildren // –Warsaw:Colloquium-journal, – 2018. №2 (13), – p. 17-19.

9. Zeynalova, İ.Z. The role of mathematical fallacy in the formation of students' logical thinking // The Republican scientific conference "Fundamental problems of mathematics and application of intellectual technologies in education". – Sumgait: Sumgait State University, – July 3-4, – 2020, – p. 240-242.

10. Zeynalova, I.Z. Mathematical problem as a means of developing logical thinking in students (Grades III-IV) // Modern education: scientific approaches, experience, problems, perspectives. XIV International scientific-practical conference "ARTEMOVSKY CHTENIYA" – Penza, –April 18-19, – 2018, – p. 203-205.

11. Zeynalova, I.Z. Requirement for using logical problems in teaching mathematics at school // – Saransk: University experiment in image. The scientific - methodical journal – 2019. №3 (91) (July-September), – p. 82-86

12. Zeynalova, I.Z. Use of logical problems in the context of visual modeling in teaching mathematics // – Yaroslavl: Yaroslavl Pedagogical Bulletin,– 2020. № 2 (113), – p. 67-72.

13. Zeynalova, I.Z. Advantages of solving logical problems on an interactive board // IV International scientific and practical conference “Psychological and pedagogical problems of modern education: ways and means of their solution”, – Makhachkala, M: Parnas, – February 27, – 2021, – p.272-275.

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