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Possibilities of mathematical problems in logical thinking. Development of secondary education pupils

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Abstract

In the article pedagogical prerequisites are considered for the performance by younger school students of the system of assignments in mathematics as a method of forming logic acknowledges skills and means of the practical study of logical concepts. As a method, circular schemes, models of real objects and verbal descriptions of logical relationships are used without reliance on visual models at three different levels. As a conclusion, junior schoolchildren are convinced that the process of learning and cognition is not limited by lessons and textbooks of mathematics, they permeate their entire life.

Key words: logical thinking, junior schoolchild, mathematics lesson, problem situation, geometric content.

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Posibilidades de los problemas matemáticos en el pensamiento lógico. Desarrollo de los alumnos de educación secundaria

Resumen

En el artículo se consideran los requisitos pedagógicos para el desempeño de los estudiantes más jóvenes del sistema de tareas en matemáticas como un método para formar conocimientos lógicos, habilidades y medios para el estudio práctico de conceptos lógicos. Como método, los esquemas circulares, los modelos de objetos reales y las descripciones verbales de las relaciones lógicas se usan sin depender de modelos visuales en tres niveles diferentes. Como conclusión, los niños de escuela primaria están convencidos de que el proceso de aprendizaje y cognición no está limitado por las lecciones y los libros de texto de matemáticas, sino que impregnan toda su vida.

Palabras clave: pensamiento lógico, alumno de secundaria, lección de matemáticas, situación del problema, contenido geométrico.

1. INTRODUCTION

Logical training is a necessary and important element in professional training future teachers of pedagogical educational institutions. It is inextricably linked with psychological-pedagogical, methodical and special training. Results of research indicate that it is expedient to formulate general logical skills in connection with the

teaching basic disciplines (Karmil-Smith and Inhelder, 1975). The most suitable discipline to formulate logical literacy of students is mathematics because of its characteristics as a science and academic subject. The content of general logical training of students as a whole is defined and represented by a list of skills that constitute the so-called logical literacy. Analysis of the existing practice of logical training primary school age children confirmed our conclusions. Development of methodological principle for the logical training of students in teaching mathematics is one of the main tasks of our research.In this regard, we can list the techniques for finding solutions of problems, which are the subject of special study and assimilation in our methodology.

2. MAIN PART

In the primary education process, one of the sources to formulate and develop logical thinking in younger schoolchildren is the system of propaedeutic exercises. However, these tasks will become a means of developing logical thinking only when the mental activity of the students will be properly directed and supervised by a teacher during their implementation (Hudson et al., 2015; Henderson and Rodrigues, 2008;Sezen and Bülbül, 2011).In a number of methodological studies, general methodological principles of the work on formation logical knowledge and skills in teaching mathematics at school have been determined. Based on the analysis of these works, and taking the specifics of modern elementary school into account, we formulated the

following fundamental principles of organization logical training (Stolyar, 1977; Koray and Koksal, 2009).

1. Accounting age characteristics. At logical training of junior classes' pupils it is necessary to consider their age features, and apply the technique corresponding to this age. It is necessary to apply such methodical methods that will allow us to explain to children how to compare objects, build definitions, perform classification, and conduct simple conclusions and proofs.

2. Continuity. Propaedeutical logical work with pupils of junior classes is designed to ensure its continuity with the middle level of the school. This is due to the fact that a "through" content-logic line is laid in the modern school mathematics course.

3. Systematicity. Work aimed at developing logical thinking among junior pupils should be conducted purposefully and systematically. This means that study of logical knowledge cannot be concentrated at a particular place in the course of mathematics in junior classes. It is carried out gradually and systematically on the material of various topics of the program, which in its turn will ensure the gradual formation of general logical skills, lay foundation for the development of more complex logical forms of thinking.

4. Availability. Study of sections of the mathematics course for junior classes is impossible without certain logical knowledge and skills. Therefore, logical concepts and actions need to be

given a form that would make their assimilation available to children.

Logical methods of thinking cannot independently be formed in children at the level of cognitive development when entering school. The teacher should lay the foundations of logical knowledge and skills (Valeeva and Shakirova, 2015; Dmtpc, 2011). Considering the age opportunities of children, every action should be worked out in a material and materialized plan with the obligatory pronunciation of each operation. The work on formation of logical concepts and actions has propaedeutic nature, since it lacks logical terms and their definitions; moreover, it is not required knowledge of certain logical rules from school children. This work is aimed at the formation of pupil's elementary logical knowledge and skills, which are the basis for further education. To formulate logical knowledge and skills in junior schoolchildren, we should use a variety of learning tools that contain material of different levels of abstraction. At the first level, at the lowest, as an indicative basis of action there appear specific items. As visual models of operations and relationships, we can use circular schemes. At the next level of abstraction, models of real objects are used, materialized using tables, matrices, drawings, diagrams, schemes that provide a visual support for the required logical actions. At the third level, verbal descriptions of logical relationships are used without reliance on visual models. This level is the highest by the degree of didactic material abstraction. These principles are realized in a specially designed system of tasks that provide formation of basic general logical skills. This system consists of five sections:

"Identifying the features of objects and operating them", "Working with logical words", "Classification", "Definitions", "Inferences". Fulfillment the problems system by junior schoolchildren is considered by us both as a method of formation logical knowledge and skills, and as a means of their practical study logical concepts, actions and disclosure of their connections. Thus, the work on logical training of junior schoolchildren should be based on the following foundations:

1) Organic connection with specific (strictly mathematical) content of the course;

2) Continuity between primary and secondary schools;

3) Gradual, purposeful and systematic formation of each skill;

4) Gradual increase of the abstraction level of the proposed material and the methods of operating it (from actions with real objects to operating their models and verbal descriptions);

5) Disclosure the general validity of logical relations and forms by attracting a diverse content (both mathematical and non-mathematical) to formulate the same skills;

6) Mastery by logical skills without using special terminology.

We have tried to implement these principles in a specially developed system of exercises, which provides for the formation of the entire complex of logical skills in the teaching junior schoolchildren to mathematics. Let us consider the ways and means that it is possible to

develop the logical thinking of schoolchildren in the process of teaching. Results of the psychological and pedagogical research have shown that one of the main conditions that ensure the development of thinking is the preliminary setting of tasks which cause problem situations that activate the pupil's thinking activity. In connection with the consideration of this issue, we will dwell in greater detail on the concepts "problematic situation" and "problem". Problematic situation is "a difficulty realized by the subject, and he wants to find a method of its elimination" (Fridman, 1977: 145). Saying about the fact that "the process of thinking always arises there when a person encounters with some kind of intellectual difficulty, this difficulty must be within the limits of possibilities of cognitive activity" (Galperin, 1985: 23). It implies conditions for the emergence of a problematic situation: cognitive need, difficulty of the subject in performing an action, as well as cognitive capabilities of the subject.

The results of the research give the basis to assume that the mathematical problem can be used not only to study the processes of thinking, but also for its development and formation. The solution of any problem does not lead to the development of logical thinking. To successfully develop the pupils' logical thinking, it is necessary a system of tasks, such that solving them schoolchildren would face with problematic situations and resolve them. Obviously, the content of the tasks and methodology for their formulation should be such that the logic of pupils' search activity, ways of finding an answer to the question posed in the problem, were related to pupil’s cognitive efforts, representing a sequence of inductive and deductive cognitive actions in

their various combinations. Moreover, both inductive and deductive logical processes invariably take place with the participation of a whole series of other interrelated operations of thinking (comparison, analysis, synthesis, generalization and etc.), therefore the formation of these thinking processes should be envisaged both in the content of the problem and in the method of their setting.

To compose a system of problematic situations, it is necessary to consider the following:

1) The system of problematic situations should cover the whole studied topic;

2) In each problematic situation, as an unknown, only one assimilated relation, principle of action or essential condition for its fulfillment should act;

3) In the system of problematic situations in various stages of mastering the topic various problematic situations must perform various didactic functions;

4) Problematic situations should compose the consecutive steps that each pupil should realize in the learning process;

5) Developing a system of problematic situations, first it is necessary to identify the basic units of knowledge and actions that should be learned, determine the degree of their generalization and optimal sequence.

In the learning process, the problematic situation performs a threefold function:

1) Acts as an initial part of the assimilation process;

2) Provides the basic conditions of the assimilation process;

3) Acts as the main means of monitoring the assimilation process - as a means of identifying the level of development and the results of leaning and training. We recall the definition of problems with mathematical content. Problems with mathematical content are problems aimed at developing logical thinking, based on geometric material, in the form of scenes problems. Since using these problems we want to develop logical thinking of pupils, we put in front of pupils such a system of problems that solving each new problem the student faces some problematic situation. In pedagogical literatures, there are different approaches to classify problems. From the position of activity approach to teaching, the school mathematical problems can be divided into algorithmic problems, the solution of which is uniquely determined by some algorithm, semi-algorithmic and semi-heuristic, whose solution is ambiguously determined by some scheme containing both algorithmic and heuristic instructions, heuristic, a solution of which is not guaranteed by a finite number of steps, just suggests their choice from many options. In the last case, it is necessary not only logical thinking, but also intuition (Matyushkin, 1972). Teaching schoolchildren to solve problems

with geometric content, we develop not only formal logical, but also intuitive components of thinking, so we mainly use semi-algorithmic and heuristic problems. To teach all pupils ability to solve such problems independently, it is necessary to teach them how to find a way to solve these problems. Methodists talk about necessity "to include in all components of the methodological system of teaching mathematics such an element as the formation of methods of pupils' learning activities in the learning process" (Krupich, 1985: 44). They distinguish four groups of learning activity methods: general learning methods, general methods of learning activities in mathematics, special methods of learning activities for individual mathematical disciplines, private methods of teach activity. Teaching pupils to solve problems with geometric content, it is necessary to pay attention to search for a solution of the problem. In this connection, we enumerate the methods of searching for a solution of problems, which are the subject of special study and assimilation in our technique (Epishev, 1999).

1. Method of the search for a solution of the problem by means of analogy. Analogy used in mathematics is one of foundations for finding solutions to problems. Quite often reasoning by analogy leads to the required result.

2. Method of analytical-synthetic search for a solution of the problem.

3. Analytic-synthetic reasoning consists in analyzing the condition of the problem; assuming that the problem is solved, pupils consider what conclusion can be drawn from it. Further, comparing the obtained conclusions (synthesis), the pupils try to find a solving method.

4. Method of special cases consideration.

5. Special case is (although not always) a simplified model of the problem. A systematic review of some particular cases of the problem can be used as a method of search for a solution.

6. Method of trial and error.

7. This is a heuristic method that is used when pupils do not have constructive ideas to solve the problem. Numerous blind trials, rejection from any methods of reasoning and again return to them, various erroneous ways of solving and, as a rule, random success, which allows to come to the right solution - are components of the "trial and error" method. Operation of this method cannot be described. It is impossible to predict what methods of solution will be considered by one or another pupil. And the number of incorrect trial and error will depend on pupils' intuition and experience in carrying out such reasoning. However, using this method, various problems can be solved, for example, problems of constructing a structure that satisfies the given

conditions.

8. Incomplete induction method.

9. Comparison method.

10. Method of the search for all solutions, using the graph.

11. Next, we show what didactic possibilities have the problems with geometric content. Problems with geometric content help to form a geometric representation in school children. Using these problems, it is possible to form or conduct a propaedeutic of concepts as "polygonal", "polygons", "polyhedral", "equality of figures", "area", and "symmetry". Consider another important didactic function of these problems: using them, we have an opportunity to form the logical thinking of pupils and their logical culture. Using the problems with geometric content, it is possible to develop formal-logical components of thinking:

1) To teach pupils to reason correctly, by teaching them methods of proof, for example, proof by contradiction, proof by example, refutation by example, deductive reasoning;

2) To teach pupils to conduct a logical analysis, solving problems;

3) To form logic of the solution search;

4) To develop combinatorial skills;

5) To develop the ability to analyze the drawing;

6) To form mental operations: analysis, synthesis, comparison, generalization, concretization, abstraction, classification;

7) To understand the meaning of words and phrases "necessary", "sufficient", "at least", "least quantity", "largest quantity" and etc., and to form skills in their use.

Moreover, using these problems, it is possible to develop intuitive and creative components of thinking: development of ideas about symmetry, development of "geometric vision", spatial imagination, geometric design, flexibility and originality of thinking. Problems with geometric content are a good way to form an internal need in proof, and this can be the most important thing. The main problem faced by mathematics teachers, training pupils of the seventh class in geometry, is that the pupils not only have no experience in constructing proofs, but there is no internal need in proof, they do not realize its necessity. However, the solution of the problem of upbringing pupils' inner need in proof should be for a long time, and it is necessary to begin this work as early as possible, not only in lessons, but also in solving specially selected systems of problems. We have already noted above that it is necessary to begin to form logical thinking as early as possible, and on a variety of material. And since in solving problems with geometric content it does not require a deep knowledge of geometry, then they can be solved by a fifth class pupil.

It means that it is possible to begin to form logical thinking, using these problems, from the fifth class. We noted that in thinking of pupils of the 5-7thclasses there is a transition from concrete-figurative thinking to abstract-logical thinking. And in problems with geometric content there is a rare combination of visualization, logic and practice. Studying geometry in the 7th class, pupils should be purposefully trained in the methods of examining the drawing; moreover, in pupils general methods of working with the drawing should be formed. To assimilate the methods of reading a drawing correctly and generically, it is not enough to explain them once by the teacher. An explanation should be repeated on different teaching materials so that knowledge of the method is not associated by pupils with specific teaching material and specific educational topic. It is possible to begin teaching pupils the frequent methods of reading a drawing already in the 5th and 6th classes and continue it in the 7thclass.Teaching pupils these problems, an object of special assimilation is the following methods of reading a drawing (Epishev and Krupich, 1990; Abylkasymova et al., 2009):

1) Inclusion the same element in different geometric figures;

2) Recognition known geometric figures in the drawing;

3) Finding common elements in different geometric figures;

4) Versatile consideration the geometric figure in the drawing.

Moreover, solving problems with geometric content, ability to transform a drawing is formed. This skill involves incoming actions,

and composition of skills to execute and read the drawing, as well as performing any operations: cutting, composing, reshaping.

3. CONCLUSION

Therefore, peculiarities of the logical training future teachers are: organic relationship of logical training with other areas of professional and pedagogical training of pupils, its integral nature; the bilateral nature of the process of logical training; consideration of development features of junior pupils. Logical thinking should not be alien in the structure of a real lesson, but for its formation it is necessary to actively involve the subject content of the training material. Formation of logical thinking and educational - logical skills of junior schoolchildren can continue in out-of-school work. Content of such lessons should include not only mathematical material, but also material of other subjects: Kazakh language, nature sciences, and also empirical material taken from the pupils' daily life - their hobbies, games and relationships. Due to this form of education, junior schoolchildren are convinced that the process of learning and cognition is not limited by lessons and textbooks of mathematics, they permeate their entire life.

REFERENCES

ABYLKASYMOVA,A. 2009.**Drawing Cross-section of Polyhedra**.P. 96.Almaty: Atamura. Kazakhstan.

DMTPC, K.2011. **Developing mathematical thinking in the primary classroom**.http://blog.dundee.ac.uk/mathematical-thinking/.Kazakhstan.

EPISHEV, O. 1999.**Activity approach as a theoretical basis for designing a methodical system of teaching mathematics**.Th.Doct. Ped.Sciences.p. 357. Moscow. Russia.

EPISHEV, O., and KRUPICH, V. 1990.**Teach Schoolchildren to Study Mathematics**.p. 127.Moscow.Russia.

FRIDMAN, L. 1977. **Logical and psychological analysis of school teaching problems**.p. 208.Moscow. Russia.

GALPERIN, P. 1985. **Methods of teaching and mental development of a child**.p. 45. Moscow: MGU. Russia.

HENDERSON, S., and RODRIGUES, S. 2008. **Scottish student primary teachers' levels of mathematics competence and confidence for teaching mathematics: Some implications for national qualifications and initial teacher education**. Journal of Education for Teaching. Vol. 34. pp. 93–107. Kazakhstan.

HUDSON, B., HENDERSON, S., and HUDSON, A. 2015.**Developing mathematical thinking in the primary classroom: liberating students and teachers as learners of mathematics.** Journal of Curriculum Studies.Vol. 47 N°3: 374-398. DOI: 10.1080/00220272.2014.979233. Kazakhstan.

KARMIL, A., and INHELDER, B. 1975.**If you want to get ahead, get a theory**. Cognition 3. pp. 195–212. Kazakhstan.

KORAY, Ö., and KOKSAL, M. 2009.**The effect of creative and critical thinking based laboratory applications on creative and logical thinking abilities of prospective teachers**. Asia-Pacific Forum on Science Learning and Teaching. Vol. 10. N° 1: 1. Kazakhstan.

KRUPICH,V. 1985. **Structure and Logic of the Process of Teaching Mathematics in School**. p. 117. Moscow: Russia.

MATYUSHKIN,A. 1972.**Problematical Situations in Thinking and Learning**. Pedagogy. p. 168. Moscow. Russia.

SEZEN, N., and BÜLBÜL, A.2011.**A scale on logical thinking abilities.***Procedia Social and Behavioral Sciences***.**Vol.15. pp. 2476–2480.Russia.

STOLYAR, A.1977.**On some applications of logic in pedagogy to mathematics. Logic and problems of training.** M: Pedagogy. pp. 125-139. Russia.

VALEEVA, R.,and SHAKIROVA, K. 2015.**Development of the Future Mathematics Teachers' Constructive Skills**.International Electronic Journal of Mathematics Education.Vol. 10.N^{o} 3: 221-229. Russia.

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