Divergent tasks as a means of developing the creativity of younger students

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***Abstract*–The article reveals the possibility of developing creativity of younger students using divergent tasks in the educational process. We have developed a methodological approach to the formation of creativity among younger students in the process of their learning to solve divergent tasks and the purpose of the article is the presentation of this methodical approach. The methodological basis of the article were:**

- **Activity concept of learning;**
- **The principle of the leading role of education in the development of students;**
- **The main provisions of the theory and methods of teaching mathematics in primary school;**
- **Ideas on updating school education in the XXI century.**

The following research methods were used in the article:

- **theoretical analysis of psychological, educational and educational literature on the problem of research;**
- **the study and synthesis of educational experience;**
- **questioning;**
- **testing;**
- **pedagogical experiment;**
- **statistical processing of experimental results.**

The didactic conditions that ensure the effective development of the creativity of younger schoolchildren using divergent tasks in the learning process are revealed. A key set of divergent tasks with the method of teaching them to solve younger students, which effectively develops the creativity of their thinking, has been developed. A list of the main types of divergent tasks is given, which have shown their effectiveness as a means of developing the creativity of younger schoolchildren in the process of searching and teaching experiments. However, when teaching mathematics, teachers focus on solving convergent tasks, rarely using divergent tasks aimed at developing the creativity of younger students. The systematic and purposeful use of divergent tasks in teaching mathematics, the creation of a benevolent creative atmosphere in the process of teaching students and the encouragement of any divergent ideas and suggestions of students contribute to the effective formation of creative thinking in younger schoolchildren.

Keywords–divergent and convergent task, intelligence, divergent and convergent thinking, creativity, creative thinking, universal learning activities

I. INTRODUCTION

In modern conditions, when the state adopted the Federal State Educational Standard of Secondary General Primary Education, the development of the creative component of thinking comes to the fore, because modern society needs workers who are able to produce original ideas and put them into practice, able to quickly find a constructive way out from difficult and problematic situations. It is easier for a creative person to adapt in new conditions, find a creative approach to any problem and achieve high labor productivity. The task of the Russian education system is to ensure that students grow up not only healthy, educated, but also initiative, thinking, creative. A number of Russian psychologists and teachers made a large contribution to the development creativity problem; however, the results of these studies are assessed as very modest. According to D.B. Bogojavlenskaja, attempts to develop a theory of creativity did not lead to the final goal [1]. In the

didactic and methodological terms, the problem of developing creativity in younger schoolchildren with the help of divergent tasks in the process of teaching mathematics has been little studied. Therefore, the topic of this study seems to be very relevant [2].

The problem of the study is to identify possible ways to develop the creativity of younger students using divergent tasks in the process of teaching mathematics.

The purpose of the research is to develop a method for forming creativity among younger students in the process of teaching mathematics by using the developmental capabilities of divergent tasks.

II. METHODOLOGY

The problem of the development of creativity (creative thinking) attracted the attention of researchers from the middle of the twentieth century. Increased interest in this problem was associated with the division of thinking into divergent and convergent, proposed by the American psychologist D.P. Guilford [2]. Mathematical problems accumulated and tested in the course of centuries-old pedagogical practice, have served and serve as a means of developing all types of thinking, including creative. A mathematical task is the beginning of a cognitive, exploratory, heuristic, creative process; it awakens thought, stirs thinking and develops creative thinking. School teachers usually use **convergent tasks** that have a well-defined condition, a rigorous algorithm for solving, and the only correct answer, which are designed to develop mainly convergent thinking. Convergent thinking is consistent, logical, unidirectional thinking. As noted by A.I. Savenkov: "This type of thinking is considered simpler than creative, but it doesn't decrease its importance in shaping the child's learning. Intellectual skills formed in the course of solving these problems have a common character" [3]. However, life poses **divergent tasks** for a person, having many variants of correct answers and, accordingly, various solutions. In traditional mathematics education, divergent type problems are quite rare. However, the effectiveness of developing creativity through such tasks is very high, because the multivariate responses and solutions to such problems creates optimally favorable conditions for realizing the creative potential of the child, allowing him to show fluency, flexibility and originality of thinking during the work on the task [2].

The methodological basis of the study were:

- general scientific methodology that considers objects and phenomena of objective reality in their interrelation and interdependence;
- activity based learning concept (L.S. Vygotsky, V.V. Davydov, P.Ya. Gal'perin, A.N. Leontyev, D. B. Elkonin);
- the principle of the leading role of education in the development of students (L.S. Vygotsky, L. V. Zankov, P. M. Erdniev);
- The basic principles and principles of the theory and methods of teaching mathematics in primary school (A.K. Artemov, M.A. Bantova, A.V. Beloshistaya, G.V. Beltyukova, N.Ya. Vilenkin, V.V. Davydov, L.V. Zankov, N.B. Istomina, Yu.M. Kolyagin, M.M. Moreau, A. M. Pyshkalo, P. M. Erdniev);
- ideas of works dedicated to the renewal of school education in the XXI century (N.V. Ammosova, A.G. Asmolov, D.P. Gilford, V.K. Dyachenko, A.N. Kolmogorov, A.M. Matyushkin, A. I. Savenkov, E.P. Torrance, and others) [2].

The following research methods were used in the article:

- theoretical analysis of psychological, educational, scientific, methodological and educational literature on the problem of the development of creative thinking of younger schoolchildren;
- the study, analysis and synthesis of advanced pedagogical experience on the research problem;
- questioning and testing of both students and primary school teachers on the research problem;
- a pedagogical experiment consisting of three stages with statistical processing of results using the Mann-Whitney test and the Page test.

At the control stage of the pedagogical experiment, we used the batteries of creativity tests created by E.E. Tunik [4] based on the creative tests of Guilford-Torrance, and the Johnson creativity questionnaire, also adapted by E.E. Tunik [4]. The test works created by us, as well as the batteries of the Guilford- Torrance tests, allow us to reveal such individual indicators of creativity as fluency, flexibility and originality of thinking.

III. RESULTS

The need to begin the development of creative thinking in younger students in the learning process, starting from primary school, is due to the fact that:

- learning plays a leading role in the child's psychological development (L.S. Vygotsky [5]);
- thinking is a prerequisite for all other activities; Any activity is its final and revised result in the end (Y.A. Ponomarev [6]);
- if the creative makings of a child are not stimulated in childhood, then there will be no creativity (A.M. Matyushkin [7]);
- A sensitive age for the development of abstract logical and creative thinking falls on primary school (L. S. Vygotsky, V. A. Krutetsky, N. S. Leites, A. M. Matyushkin);
- Creative activity is associated with the active work of the child's thinking and this activity has a positive effect on the development of all its mental functions (N.B. Istomin [8]);
- A person becomes creative if he develops during the entire period of schooling. Primary school is a very important stage for the creative development of

the personality, since all education in the upper grades is based on the knowledge gained in the lower grades. The nature of mental activity begins to take shape also in primary school and is most subject to the pedagogical influence (N.V. Ammosova [9]).

A theoretical analysis of the psychological and pedagogical literature on this issue allows us to formulate the conclusion that the development of creative thinking in younger students suggests [2]:

1. Systematic and targeted use in teaching mathematics didactic possibilities of divergent problems.

2. Creating in the process of teaching students a benevolent creative atmosphere, encouraging any divergent ideas and suggestions.

3. The use in the educational process of a variety of innovative tools for teaching mathematics.

4. Demonstration of positive samples and examples of the manifestation of creative thinking by the teacher and others.

5. The traditional content of education is an organic part of the socio-cultural environment and cannot really be rationally changed without changing this environment as a whole. Therefore, the development of creativity must be carried out by enriching the content, which is traditional for the Russian elementary school (A.I. Savenkov [3]).

It is concluded that the didactic conditions necessary for the development of creativity of younger students using divergent tasks in the educational process are:

1. Systematic and purposeful inclusion in the educational process of divergent tasks aimed at the development of creative thinking.

2. Continuous exercise and training of children in search of solutions to divergent problems.

3. Creation of a favorable and benevolent educational environment for children during the lesson and after school hours.

4. Acquaintance with the methods of diversification of conditions, requirements and ways of solving problems, and approaches to their solution.

5. Ensuring a sufficient effort of the child in the search and in the process of solving problems.

We provide a list of the main types of divergent tasks that were found and used in the process of search and training experiments; these tasks have shown their effectiveness in the development of the creativity of thinking of younger students [2, 10]:

1. Divergent tasks associated with motion.

2. Combinatorial tasks.

3. Tasks related to the variety of measurement values.

4. Tasks for the construction and construction of geometric shapes.

5. Tasks for the composition and representation of numbers.

6. Tasks for optimization.

7. Tasks for magic squares.

8. Tasks for common features.

9. Tasks on the version of the causes of events.

10. Tasks for the preparation of a given solution or equation.

11. Tasks with missing data.

12. Tasks with redundant data.

13. Tasks related to the variety of materials used.

14. Tasks to overcome the inertia of thinking.

15. Prognostic tasks.

This list of basic types of divergent problems does not exhaust all of their diversity, but gives a very definite idea about them, about how to compose them and use them in the process of teaching mathematics.

Next, we will demonstrate several key examples of divergent problems with a technique for solving them, borrowed from the author's works [2, 11-16].

Task 1. The tourist sailed on a raft along the river 12 km, and returned back by boat, spending 10 hours for the whole journey. What is the speed of the river, if the speed of the boat in standing water is 5 km / h?

It is clear that for high school students this problem is convergent and reduces to solving a quadratic equation. For younger students this problem is divergent, which they can solve, based on the following idea: A tourist can come back only if the speed of a river is less than 5 km / h, that is 1, 2, 3 or 4 km / h . Directly checking, children can establish the actual answer: 2 km / h and 3 km / h.

Task 2. The distance between two cars, moving along the highway at speeds of 60 km / h and 80 km / h, respectively, is 100 km. How far can they be in 1 hour?

4 cases are possible here, of which 2 cases are in the same direction and 2 cases in opposite directions depending on the relative position of these cars relative to each other. To make it easier for children to find possible solutions, it is very appropriate to use the auxiliary model of the problem in the form of a schematic drawing. As a result, we get 4 answers: 40 km, 240 km, 80 km and 120 km. Of course, other answers are possible here, if the car stops, turns to the side, etc.

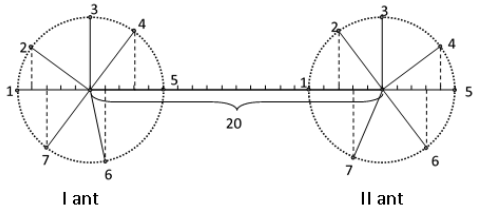
Task 3. How many potatoes were harvested from 12 plants, if 7 potatoes were collected from two plants, 9 potatoes from three plants, 6 potatoes from seven plants and 5 potatoes from eight plants.

This problem is with redundant data, since its condition gives the results of the yield of 20 plants, whereas the data for 12 plants are sufficient to solve it. As a convergent problem, it has no solution. However, as a divergent problem, it has many answers that range from 64 to 83 potatoes. Consider two extreme solutions:

7×2 + 9×3 + 6×7 = 83(potatoes); 2) 5×8 + 6×4 = 64(potatoes).

Task 4. The distance between two anthills is 20 meters. 2 ants simultaneously climbed out of these anthills and ran at a speed of 5 meters per minute. At what distance they will be in 1 min?

As we see, there is uncertainty in the problem statement, since it is not known how the ants crawled: towards each other, in the same direction, in opposite directions from each other or in some other way. This uncertainty leads to many correct answers ranging from 10 m to 30 m. In order for children to find the majority of solutions to this problem, the teacher must help them create a model of this task in the form of a drawing:



Task 5. The lengths of the sides of the triangle are expressed in integers, and the length of one - 7 cm, and the other - 4 cm. What is the length of the third party?

Using the drawing of a triangle, children should come to the conclusion: the sum of the lengths of the two sides of the triangle is always greater than the length of the third side. Here, children are assisted by intuition and life experience. Then they will be able to find all 7 answers to the question of this problem: 4, 5, 6, 7, 8, 9, 10 (cm).

Task 6. How to divide a rectangle into 2 equal parts using one straight line? How many ways can this be done?

Usually, students find four ways without difficulty, and then they declare the absence of other answer options. In fact, there are plenty of such ways of dividing a rectangle into two equal parts, because any straight line drawn through the center of the rectangle divides it into two equal parts. The task of the teacher is to push the children to this conclusion.

Task 7. A man saddled a horse and told his young son: I want to take you to grandmother, and you determine in what order we can move along the road? Give the answer to the question of the problem.

This task is combinatorial and has at least 14 answers, depending on the relative position of the father, the child and the horse, including riding on a horse, alone or together. The task of the teacher is to help children find solutions.

Task 8. How many identical squares can be folded out of 12 matches?

Most often, children cope with the construction of no more than 4 squares. However, if the teacher helps them to overcome the inertia of thinking, then they will be able to go into space and propose the construction of a cube, whose 12 edges are matches.

In order to test the effectiveness of using the opportunities of divergent tasks for the development of creative thinking of younger schoolchildren, we conducted pedagogical experiments in primary schools of four schools in the cities of Grozny and Argun and in several basic schools of the city of Makhachkala. The results of these studies are reflected in the works of the author [2, 11-16] and are given in the conclusion of this article.

It was established during the experiment that:

— an increase in creativity in experimental classes when using divergent problems reliably at the 1% significance level, that is, the use of divergent problems in the process of teaching mathematics effectively develops the creativity of thinking among younger students;

— purposeful work on the development of thinking creativity in primary school pupils is not carried out;

— students are very wary of divergent tasks, regarding them as “wrong” or “unsolvable”;

— most of the teachers found it difficult to identify the differences between intelligence and creativity (creativity) and, moreover, their interconnection;

— in mathematics lessons, they prefer convergent problems, which are primarily aimed at developing convergent thinking.

IV. CONCLUSION

The work carried out within the framework of this study allows to draw the following **conclusions**:

1. The division of thinking into convergent and divergent, proposed by J. Guilford, served as a fresh trend and a powerful impetus in research on the development of students' creative thinking.

2. In traditional mathematics education, as a rule, the development and formation of divergent thinking in students is not given enough attention, whereas it is the main factor aimed at developing the creativity of younger schoolchildren.

3. In the course of the experiment, it was found that:

1. Purposeful work on the development of creativity of younger schoolchildren in the process of teaching mathematics is often not done, the work on the development of creativity is spontaneous.

2. Traditional mathematics programs and textbooks do not provide for a sufficient number of

divergent tasks and tasks aimed at developing divergent thinking, while the number of convergent tasks and tasks aimed at developing convergent thinking prevails.

3. Teachers do not have a sufficient number of teaching aids and recommendations, as well as didactic materials that contribute effectively and purposefully to develop the creativity of younger schoolchildren.

4. It is revealed that between the didactic means for the development of creative thinking used by primary school teachers and the means currently offered by teachers and psychologists there are serious differences.

5. The didactic conditions that ensure the effective formation of divergent thinking among younger schoolchildren in the process of developing their creativity are revealed.

6. Methodical techniques, that allow transforming a number of traditional convergent tasks into divergent ones, have been found and proposed.

7. A key set of divergent problems has been developed with a method for solving them by younger schoolchildren, which allows them to effectively develop the divergence of their thinking and, as a result, their creativity.

8. The results of a theoretical study and our pedagogical experiment show that if we use a set of divergent tasks and tasks with the appropriate methodology for organizing their solutions in the process of teaching students mathematics, this develops the necessary components of creativity in students.

9. It was established that the skillful organization of the educational process is important for the development of creativity and, in particular:

— giving the child more freedom in choosing activities;

— early start of focused work in this direction;

— benevolent, unobtrusive and creative attitude towards the child's activities in the learning process [2, 11-16].

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