STAGES OF DEVELOPMENT OF THINKING IN ELEMENTARY SCHOOL

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Abstract. *The article presents a study devoted to studying the nature of the transition of primary schoolchildren from solving problems based on empirical thinking to solving problems based on theoretical thinking. Pupils of the first, second and third grades of two contingents participated in the group experiments: students studying under experimental programs developed by D.B. Elkonin and V.V. Davydov, 166 children, and according to regular primary school programs, 165 children. All students solved spatial-combinatorial problems of the author's "Game in 3" methodology in a visual-figurative manner. It has been shown that the largest increase in the number of children solving problems based on theoretical thinking is associated with learning in the second grade. At the same time, it was found that training in experimental programs creates conditions for children to more intensively master theoretical thinking. In the future, it is planned to characterize the features of problem solving based on theoretical thinking among fourth-graders.*

Keywords: *first, second and third grade students, "Game 3" methods, empirical thinking, theoretical thinking, visual-figurative form of actions, spatial-combinatorial tasks.*

1. Introduction. According to the concept developed by S.L. Rubinstein [4], two stages can be distinguished in the development of human thinking. At the first stage, thinking is characterized by a person as empirical in content and rational in form, at the second stage - as theoretical in content and reasonable in form. At the first stage, the uniqueness of thinking lies in the fact that the child, when solving problems, can act only in accordance with natural rules relations between objects, and on the second – on the basis of these relations. If the form of thinking in the first case is not separated from the content, then in the second it is recognized as an independent content, which is expressed in isolating the general principle for solving a certain class of problems from the individual features of the conditions of each problem.

In accordance with the above provisions, the main goal of our experiments, the content of which is outlined below, was to establish how a change in types of thinking occurs at primary school age, when children transition from empirical orientation in task conditions to their solution to methods of theoretical orientation. At the same time, the problem was solved in order to show the uniqueness of the development of theoretical thinking of younger schoolchildren when studying according to programs specially designed to ensure more intensive development of this type of thinking in children [1].

Thus, the specific goal of our experiments was to establish when in the primary grades and what part of children moves from methods of empirical thinking when solving problems to theoretical thinking, i.e. to the actual theoretical orientation in the conditions of the problems being solved, associated with the identification of significant relationships. In accordance with this, when constructing experimental situations based on the material of different problems, the differentiation and qualification of the results of solving problems as carried out on the basis of empirical or theoretical thinking was methodically ensured.

2. Materials and methods.

To achieve the above goals, we used the "Game of 3" technique [2], which we developed, which is a modification of the well-known puzzle "Game of 15."

First, the study conducted individual experiments. Their goal was, firstly, to adapt the solution conditions and complexity of problems of the "Game in 3" technique for students in the first, second and third grades and, secondly, to conduct a qualitative analysis of the process of solving problems of this technique. Then, in order to establish the characteristics of the distribution in each elementary school class of children who solved problems based on theoretical orientation in their conditions (“theorists”), group experiments were conducted.

As a result of individual experiments, a task was developed based on the “Games in 3” tasks, including two training and six main tasks.

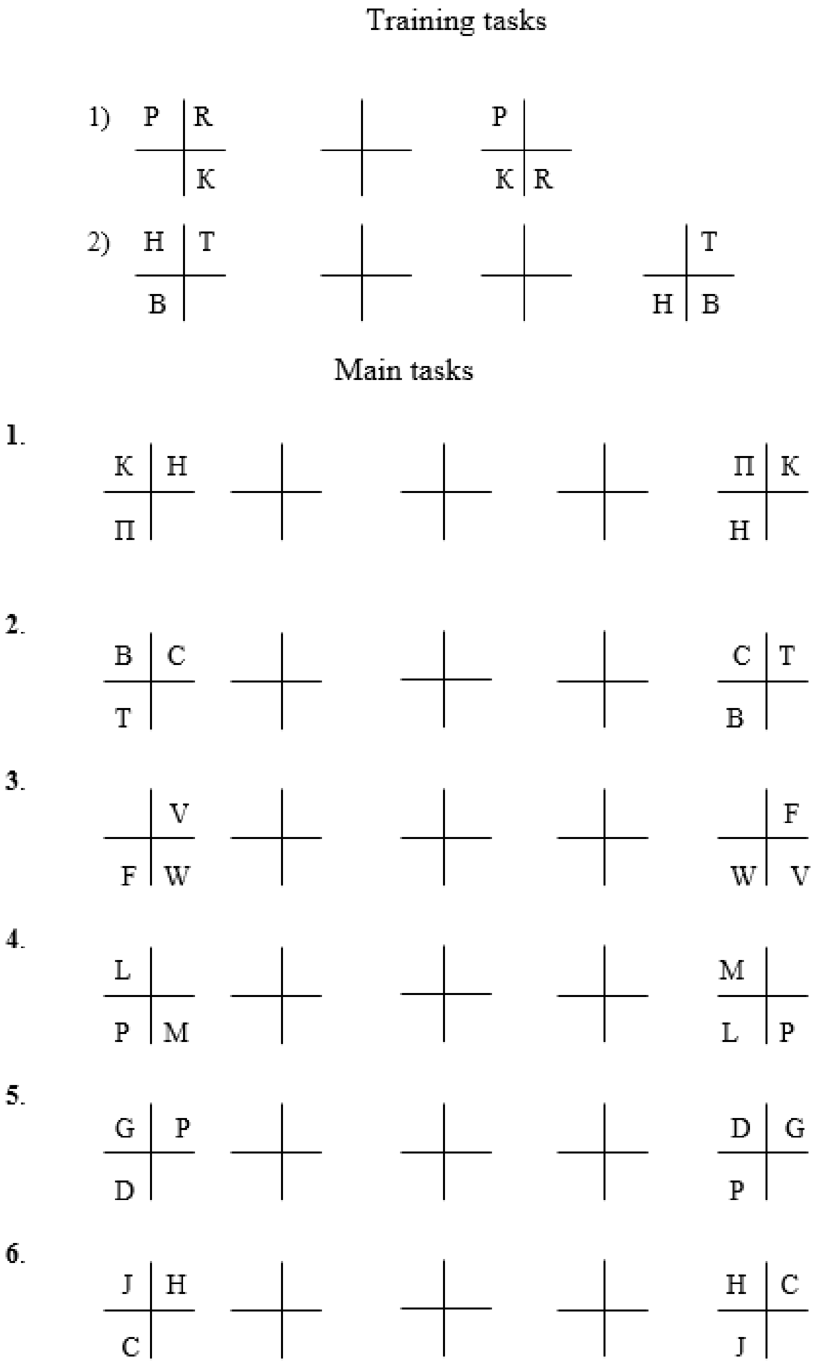

Fig. 1. Group experiment task

A group experiment with a full class of elementary school students went like this. First, each student in the class was given a sheet with the above task: two training and six main tasks.

It should be noted here that many different versions of the task were used in the class, since it was enough to change the consonants in the task conditions. This created favorable conditions for younger schoolchildren to solve problems independently.

After distributing sheets of problems, the experimenter, using a blackboard, explained the rules for moving letters on the material of one problem "Games of 3" in two moves. This was a problem similar to the first training problem, only with different letters. The children were told that the letters located in four "cells" on the left form their initial location in the task, and the same letters located in four "cells" on the right form their final, required position, which is obtained if these letters are moved twice in the initial positions.

It was noted that in one move in these problems one movement of any letter into a free, necessarily adjacent (i.e. vertically or horizontally) cell is accepted; the remaining two letters remain in their places. It was also specially emphasized that the next movement of the letter itself is carried out mentally, "in the mind" - as the addition or subtraction of two numbers, and the result of this movement is written in a four-cell "square" with free cells, which is located between the initial and required locations of the letters. When recording the next action, the cells of the free intermediate "square" are used. In this case, you need to write down the letter that was mentally moved in the free cell next to it, and rewrite the remaining two letters in the same cells where they were before moving the first of these letters.

The experimenter showed how the solution, for example, to this two-move "Game of 3" problem is solved and written down:

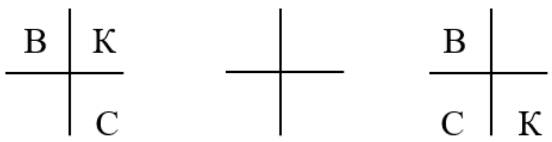

Fig. 2. Two-move "Game of 3"

In this problem, the first move is to move the letter "C" to an empty cell, since in the required position it occupies the lower left corner of the square, and the remaining letters are rewritten in their places. After the letter "C" moves to the required place, the next move (mentally) can move the letter "K" to the required position. But this move is not fixed in any way, since its result is already given in the form of the required location.

So the solution to this problem looks like this:

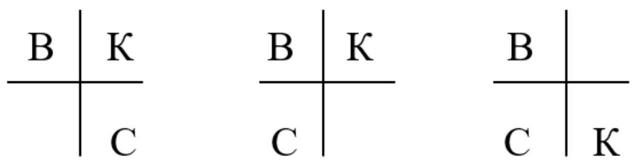

Fig. 3. The solution of two-move "Game of 3" problem

After explaining how the Game of 3 problems were solved, the experimenter wrote down on the board the conditions for a new similar two-move problem. The children had to solve it on their own, having first rewritten the conditions on the back of the task sheet, which contained two training problems and six main problems. Next, the experimenter checked each student's solution to this problem and the correctness of its format.

If everything was correct, then this student was asked to solve the first training problem located on the sheet with the task. After checking its solution and, if necessary, after making the necessary comments, the second training problem should be solved. After solving it correctly, the experimenter asked these children to solve the main problems.

It should be noted that the six main problems objectively belong to one class, the construction and solution of which is based on the initial relationship between the places of letters in the initial and required positions. The fact is that two letters standing in the initial position diagonally (i.e., in places adjacent to a free cell), in the final position naturally change their placement: one of these two letters takes the place another letter, i.e., diagonally from its original position, while the other occupies a cell adjacent to the cell in which this letter was in its initial position.

Based on this relationship, a general method is built, consisting of four operations. In other words, in order to solve any basic problem, you must, firstly, move to a free cell the letter that, in the required position, occupies a place located diagonally from the cell in which this letter is in the initial position; secondly, move to a free cell the letter that in the initial position is adjacent to the first letter that was moved; thirdly, move the third of these letters to a free cell; fourthly, the first of the moved letters must, with the help of another mental movement, get to the cell where it is in the required position.

Individual experiments made it possible to identify procedural aspects characteristic of the empirical and theoretical solution of these six main problems. Children who solved problems based on empirical orientation in their conditions ("empiricists") usually acted on the impression of how far the letters in the initial position were from the cells that they should occupy in the required position.

As could be observed, these children did not engage in searching and testing activity that would provide them with a consistently correct solution. Usually they immediately, without much thought, moved one of the two letters located next to the free cell to this free cell. And then they acted as if by inertia, moving subsequent letters one by one into free cells.

As a result of this approach to solving each problem, these children either solved all the problems incorrectly, that is, they did not have time to arrange the letters correctly in four moves, or they managed to solve one or two problems correctly by accident: if the first move was made by chance, letter in an open cell. It must be said that in individual experiments, taking into account even relatively favorable instruction conditions, not a single "empiricist" (including among third-graders) could correctly solve all the problems at once, without correcting errors.

The "theorists" solved these same problems differently. Observing their solution, one could note the extensive search and testing activity associated with the choice of the initial move. Both from their movements with the pen and from their statements, it was clear that they not only focused on the first letter when searching for the initial move, but also tried to establish what place the second letter would take.

In other words, they focused on a holistic formation, including two or three letters, and not on individual elements of the problem conditions, like the "empiricists." Only after making sure that the initial move was chosen correctly, the "theorists" began to write down the solution, without expanding the search for subsequent moves. It should also be noted that such an orientation in the conditions of the problems took place only on the material of the first or, more rarely, on the material of the first two problems. Subsequently, the initial move was usually identified immediately correctly.

Thus, when processing protocols with solved problems, we believed that if all problems were solved correctly and without corrections, then their solution was carried out using theoretical orientation in conditions, and if correct, but with corrections, or if not if all the problems were correct, or, moreover, everything was wrong, it was believed that in this case the problems were solved with the help of empirical orientation in their conditions.

3. Results.

The group experiments, which were conducted at the end of the school year, involved two classes of schoolchildren who had studied for 1, 2 and 3 years in different curricula. The distribution of "theorists" into classes with different curricula when solving problems in the "Game in 3" methodology in a visual and figurative form is presented in the table.

Table. The number of “theorists” in the first, second and third grades when taught in experimental and non-experimental programs

Classes	Experimental programs		Non-experimental programs	
	Number students	Number "theorists"	Number students	Number "theorists"
1	54	16 (29,6%)	56	11 (19,6%)
2	57	31 (54,4%)*	55	20 (36,4%)*
3	55	41 (74,5%)**	54	28 (51,8%)**

*Note: *p<0.05; **p<0.01.*

Analysis of the data presented in the table allows us to note the following.

Firstly, after a year of study in experimental programs, the number of “theorists” is slightly higher than the number of “theorists” studying in non-experimental programs, respectively: 29.6% and 19.6% (the difference in the noted indicators is statistically insignificant (at p> 0.05).

Secondly, after two years of study in experimental programs, the number of “theorists” significantly exceeds the number of “theorists” studying in non-experimental programs, respectively: 54.4% and 36.4% (the difference in the noted indicators is statistically significant (at $p < 0.05$).

Thirdly, after three years of study in experimental programs, the number of “theorists” significantly exceeds the number of “theorists” studying in non-experimental programs, respectively: 74.5% and 51.8% (the difference in the noted indicators is statistically significant (at $p < 0.01$).

It is important to note that after two years of training in experimental programs, “theorists” among children become the majority, while when training in non-experimental programs, “theorists” among children are slightly more than one third.

In addition, after three years of training in experimental programs, three quarters of the contingent participating in experiments became “theorists” among the children, while in non-experimental programs, “theorists” among the children of this contingent became slightly more than half.

Based on the data presented in the table, we can conclude that when teaching under experimental programs, the development of a theoretical method of solving problems and, accordingly, the development of theoretical thinking in younger schoolchildren occurs more intensively than when training under non-experimental programs.

It is important to note that when training in both experimental and non-experimental programs, the largest increase in the number of “theorists” occurs in and the smallest – as a result of training in the third grade. These data characterize the age-related dynamics of the development of theoretical thinking in younger schoolchildren, unrelated to the content of educational programs.

4. Conclusion.

4.1. Characteristics of the study

So, we conducted a study to study the nature of the transition of primary school students (the study involved schoolchildren studying in the first, second and third grades) from empirical thinking when solving problems, associated with an orientation towards the external features of the problem conditions, to theoretical thinking, associated with the identification of significant relationships in task conditions.

At the same time, the problem was also solved in order to determine the features of the transition from empirical thinking to theoretical thinking among schoolchildren of two contingents: those studying in elementary school according to experimental programs developed by D.B. Elkonin and V.V. Davydov [3, 1] and students in conventional, non-experimental primary school programs.

In the course of individual experiments, we practiced the tasks of the “Game in 3” methodology we developed and studied the procedural features of solving these problems by children of the first, second and third grades.

As a result of group experiments, in which a total of 331 schoolchildren from two contingents participated (166 children studied in experimental programs and 165 children studied in non-experimental programs), the following results were obtained.

First, experimental data indicate that the greatest increase in the number of children who demonstrated theoretical thinking when solving problems is associated (regardless of the primary school program) with training in the second grade.

Secondly, it was found that after two years of training in experimental programs, the number of children with theoretical thinking significantly exceeds the number of children with theoretical thinking studying in non-experimental programs, and after three years of training, the observed excess increases significantly.

4.2. Scientific significance of the study

The study obtained new knowledge characterizing the characteristics of the transition of first, second and third grade students from empirical thinking when solving problems to theoretical thinking. It was shown based on the material of children solving spatial-combinatorial problems in a visual-figurative form that, regardless of the training program in primary school, the greatest increase in the number of children with theoretical thinking is associated with the end of the second grade and that when trained in experimental programs, theoretical thinking develops in children more intensively than when training in non-experimental programs.

This knowledge expands and clarifies the ideas of developmental and educational psychology about the nature of the development of theoretical thinking in elementary school.

4.3. Goals of further study of the development of theoretical thinking in primary school

It is planned to conduct a study of the characteristics of the transition of primary schoolchildren from empirical thinking to theoretical thinking based on the material (as in the present study) of spatial-combinatorial problems, but solved in an objectively active form.

It is necessary to determine to what extent the results obtained in our study on the material of spatial-combinatorial problems will differ from the results that will be obtained on the material of solving verbal-logical problems.

It is of serious research interest to carry out experimental work in the same way as in this study, using the material of children solving spatial-combinatorial problems of the “Game in 3” methodology with schoolchildren studying in the fourth grade.

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СТАДИИ РАЗВИТИЯ МЫШЛЕНИЯ В НАЧАЛЬНОЙ ШКОЛЕ

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Аннотация. *В статье представлено исследование, посвященное изучению характера перехода младших школьников от решения задач на основе эмпирического мышления к решению задач на основе теоретического мышления. В групповых экспериментах участвовали ученики первого, второго и третьего классов двух контингентов: обучающихся по экспериментальным программам, разработанным Д.Б. Элькониным и В.В. Давыдовым, – 166 детей, и по обычным программам начальной школы, – 165 детей. Все ученики решали в наглядно-образном плане пространственно-комбинаторные задачи авторской методики «Игра в 3». Было показано, что наибольший прирост числа детей, решающих задачи на основе теоретического мышления, связан с обучением во втором классе. При этом было установлено, что обучение по экспериментальным программам создает условия для более интенсивного освоения детьми теоретического мышления. В дальнейшем планируется охарактеризовать особенности решения задач на основе теоретического мышления у четвероклассников.*

Ключевые слова: *ученики первого, второго и третьего классов, методика «Игра в 3», эмпирическое мышление, теоретическое мышление, наглядно-образная форма действий, пространственно-комбинаторные задачи.*