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Zak A. Characteristics of problem solving by primary school graduates

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Abstract. *The article reflects the content of the study aimed at studying the relationship between primary education programs and problem solving methods. 110 fourth-graders took part in the group experiments, some of whom (54 people) studied according to the program of D. B. Elkonin - V. V. Davydov, others (56 people) studied according to the traditional primary education program. The students were asked to solve spatial-combinatorial problems of a search nature of the "Game of Five" technique in a visual-figurative form. It was shown that training according to the program of D. B. Elkonin - V. V. Davydov to a greater extent contributes to the development of children's general, theoretical method of solving problems than training according to the traditional primary education program.*

Key words: *fourth-graders, D. B. Elkonin - V. V. Davydov primary education program, traditional primary education program, spatial-combinatorial problems, "Game of Five" technique, visual-figurative form of problem solving,*

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1. Introduction.

The modern Federal State Educational Standard of Primary General Education [6] sets the task of achieving meta-subject results by children in primary education. It is indicated that the meta-subject results of mastering the basic educational program of primary general education should reflect, in particular, the mastering by younger students of effective ways to solve problems of a creative and search nature.

The purpose of our study was to characterize the methods of solving search problems by fourth-grade students, some of whom studied according to the D. B. Elkonin - V. V. Davydov program, others - according to the traditional primary education program.

In developing the research methodology for determining the characteristics of the methods for solving search problems, we relied on the concept proposed by S. L. Rubinstein [4] and developed in detail by V. V. Davydov [2] and his followers [1], [3], [5] about two types of thinking in solving problems - theoretical and empirical, and, accordingly, about two ways of solving problems - general (generalized), meaningful, theoretical and specific (non-generalized), formal, empirical.

2. Materials and methods.

The material for developing the methodology was the well-known puzzle "Game of Fifteen", which was subjected to a certain modification. This modification consisted in the fact that instead of fifteen chips moving along a sixteen-cell playing field, only five chips were used, moving along a six-cell playing field.

As in the original puzzle "Game of Fifteen", in our modification of this game, which became known as "Game of Five", there was one free cell and chips that moved along the playing field (to the free space) in any direction with a rook move, i.e. horizontally and vertically.

So, in order to transform the original order of chips into the required order in six moves, you need to move the following chips sequentially to the free space: 1, 2, 3, 5, 4 and 1 (see Fig. 1).

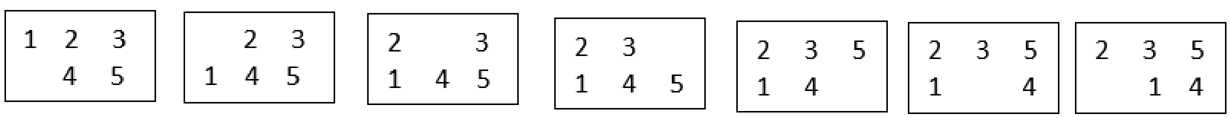


Fig. 1. Solving the problem "Game of Five" in six moves.

An important feature of "Game of Five" is the ability to develop equivalent problem situations on its basis. In this case, with different numbering of chips, the problems have the same number of moves and an identical route of movement of chips in the process of transforming the original situation into the required one.

For example, problem 1 is equivalent to problem 2 (both problems are solved in six moves).

Fig. 2. Equivalent problems.

In preliminary experiments, schoolchildren solved the "Game of Five" problems individually. Each child solved 8 eight-move equivalent problems in a visual-active plan, i.e., he moved cardboard chips by hand along a wooden board on which a six-cell field was marked.

The children were not told the optimal number of moves. This made it possible to establish on which problem the child would be able to find the principle of solving all equivalent problems, i.e., the optimal (shortest) route for moving chips for all problems in order to transform the initial situation into the required one in eight moves.

It was believed that the method of solving problems would be general and meaningful if the child found this principle (i.e., the shortest route) quickly, after solving one or two problems. If the child found the optimal route after a number of unsuccessful attempts, i.e. only after solving five or six problems and in more than eight moves, then this solution method was classified as private, formal, empirical, since it was found only after a large number of trials and errors.

Thus, in these experiments, the result of solving the problem is not related to the method of obtaining it: the correct solution (obtaining the required arrangement of chips) can be ensured by moving the chips either along the shortest route or in more than the required number of moves.

In our main experiments, an attempt was made to link these points. For this purpose, it was necessary to construct such a method (based on the material of the "Game of Five") so that the correct solution to the problem, i.e. obtaining the required arrangement of chips, presupposed a theoretical method of solution, manifested in the abstraction of the essential relationship in the conditions of the problem.

Conversely, an incorrect solution to the problem should indicate an empirical solution method, i.e., the absence of identification of essential dependencies in the problem conditions, as a result of which the problem is solved in more than eight moves.

In addition, it was necessary to modify the version of the “Game of Five” method used in the preliminary experiments into a version that can correspond to the conditions of group work in the classroom.

In this case, the child solves problems not in a visual-active form, as in an individual experiment, but in a mental plan, in a visual-figurative form. This means that the solution to the problem is not carried out by moving the token by hand along the playing field, but by mentally moving the number to a free cell of the playing field.

For ease of arrangement on a sheet of paper, the playing fields were deployed along the length of the sheet (vertically), - see Fig. 3.

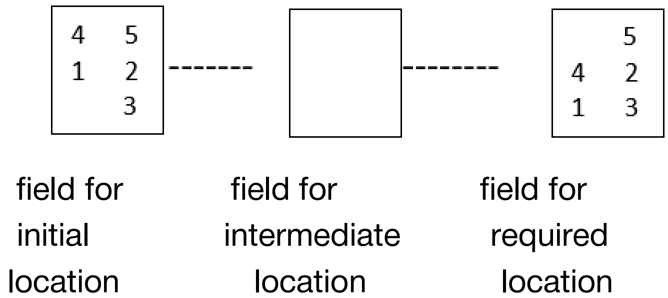


Fig. 3. Playing fields with vertical orientation.

With this orientation of the playing fields on the sheet, two numbers could be moved once either up or down (as in this example, - numbers 1 and 4).

After mentally moving the number, the resulting arrangement is written down in specially left places for this purpose, unfilled with numbers, on the intermediate playing field, located between the initial (original) and final (required) arrangements of the numbers.

When developing the methodology based on the material of the "Game of Five", it was taken into account that there are two types of routes for moving the chips along the playing field: moving along the "large circle" and along the "small circle".

In the first case, the chips move along six cells of the field, so that the direction of movement sometimes changes after two moves (see Fig. 4).

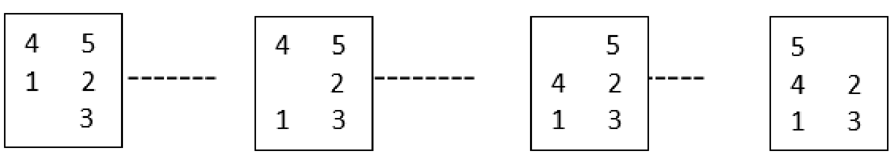


Fig. 4. Moving the chips along the "large circle".

In the given example, it is clear that the numbers 2 and 3 remain in their places for all three moves, while the numbers 1, 4 and 5 move in turn to a free cell.

In the second case, the chips move only along four (adjacent) cells, so that the direction of the chips' movement changes after each move (Fig. 5).

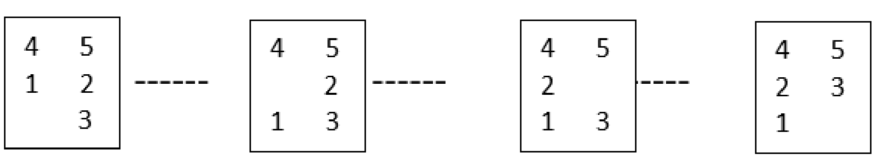
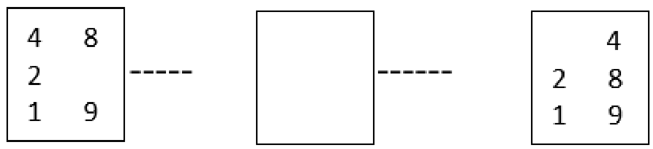


Fig. 5. Moving chips along the “small circle”.

The example shows that the numbers 4 and 5 remain in their places during all three moves, and the numbers 1, 2, 3 move one after another. These features of the chip movement routes in the “Five Game” problems were used in our methodology (see Form).

The diagnostic lesson was conducted as follows.

First, the organizer of the lesson (psychologist or teacher) depicts the problem statement on the blackboard (Fig. 6):

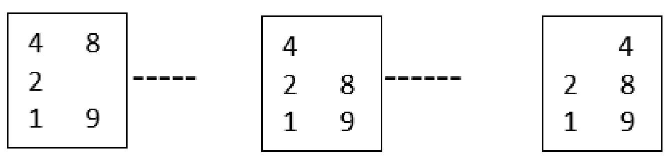


(a) (b)

Fig. 6. The first problem on the blackboard.

The children are told: “The left arrangement of the numbers (a) is the initial, and the right (b) is the final, required one. It must be obtained in two actions. One action is the mental movement of any number to a free place up, down or to the side.

In this problem, you need to do two such mental actions. First, mentally move the number 8 down, because it should not be at the top, but in the middle. Let's write down the result of this mental action like this," - the teacher writes down the number 8 in the middle of the playing field, and rewrites the other numbers - 4, 1, 2 and 9 - in their previous places (Fig. 7).



(a) (b)

Fig. 7. Solution of the first problem on the blackboard.

"With the second mental action, move the number 4 to the side. There is no need to write down the result of this movement, because it is already in the problem statement. This is how the solution to problems on moving numbers in two actions is written down."

The organizer of the lesson depicts the conditions of the second problem, where the required arrangement must be obtained from the initial one in three actions:

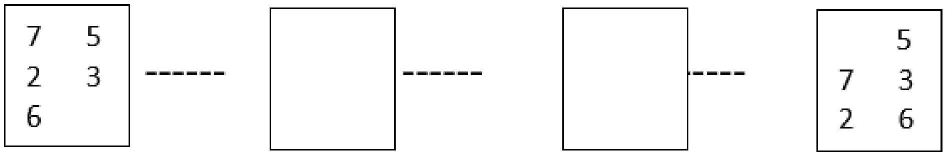


Fig. 8. The second problem on the blackboard.

The solution to this problem is considered collectively and the organizer writes down the results of the first and second actions on the blackboard, since the result of the third action is already given in the required arrangement:

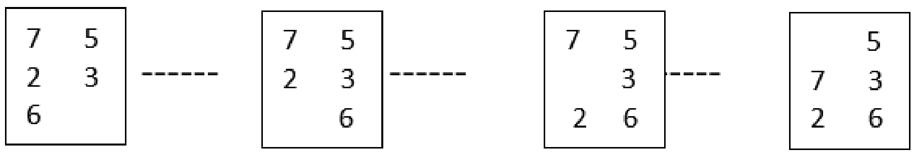


Fig. 9. The solution to the second problem on the blackboard.

At the same time, the organizer of the lesson specifically draws the children's attention to the fact that in one action only one digit changes place, and the rest are rewritten without changes.

After this, forms with three training (Nos. 1, 2, 3) and eight main problems (Nos. 4, 5, 6, 7, 8, 9, 10, 11) are distributed – Fig. 10.

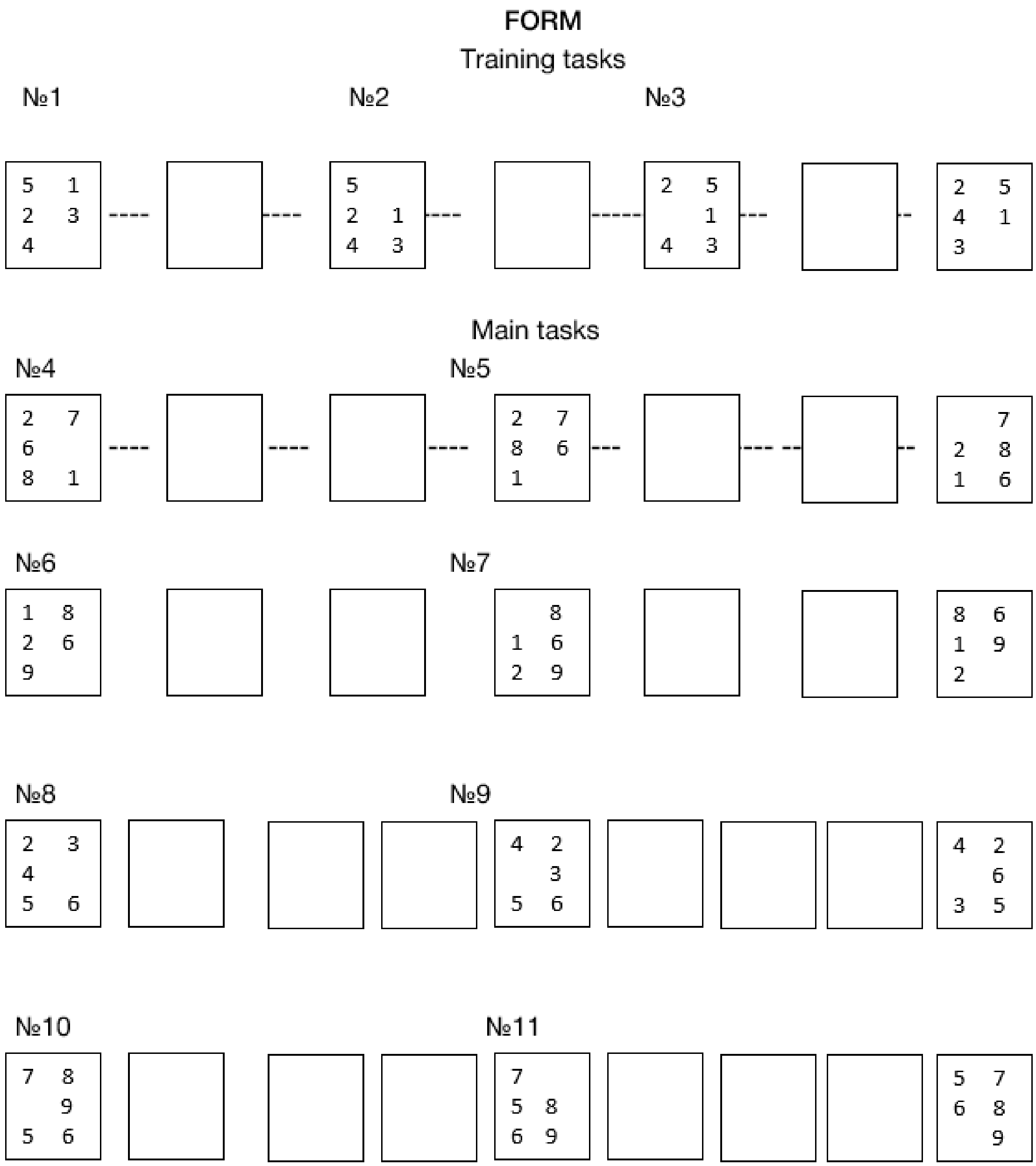


Fig. 10. Blank with tasks.

The children are asked to write their names at the top of the form and then the necessary explanations are given: "Look at the sheet. First (at the top) the conditions of three training tasks are drawn: they are solved in two steps.

Next are the conditions of the main tasks 4, 5, 6 and 7 - they must be solved in three steps. Then you need to solve the main problems 8, 9, 10 and 11, where you need to find four actions.

Now solve the training problems. Write down the solution as we did on the board - put the numbers in the empty spaces. Remember that only one number is mentally moved per action."

Walking around the classroom, the organizer of the lesson checks the solution of the training problems and helps the children correct mistakes in the movements if they immediately copy two numbers to the empty spaces, and not one. After checking the training problems, the children are asked to solve the main problems.

The noted features of the routes of movement of the chips in the "Game of Five" problems were used in our methodology as follows.

So, three-move problems (Nos. 4 and 5) were solved based on moving the numbers along the "small circle", and problems No. 6 and No. 7 - based on moving along the "large circle"; Four-move problems No.8 and No.9 were solved by moving the numbers along the “small circle,” and problems No.10 and No.11 — along the “large circle.” Problems No.1, No.2, and No.3 were two-move problems.

Thus, the correct solution to all the problems requires a theoretical method for solving them for the following reasons:

1) the smallest number of moves is regulated;

2) when solving problems, it is prohibited to use drafts or correct written numbers;

3) only two problems are constructed for each of the two route types, which allows the child to discover the optimal route and transfer it;

4) the route types underlying the solution to the problems change constantly, every two problems, in order to exclude accidental correct solutions to the problems and ensure, in turn, their conscious solution, a necessary moment of which is the child’s appeal to his own method of action, i.e. reflection.

3. Results.

A total of 110 fourth-graders participated in the group survey using the specified methodology at the end of the school year.

54 students (the first contingent of subjects) studied according to the program of D. B. Elkonin - V. V. Davydov, 56 students (the second contingent of subjects) studied according to the traditional primary education program. The data obtained in the study are presented in the table.

Table. Number of students who solved problems 1 - 11, 1 - 7 and 1-3 in the first and second contingents (in %)

Contingents	Problems		
	1 – 11	1 – 7	1 – 3
First	74,1*	24,1	1,8
Second	53,6*	42,4	3,5

Note: *p < 0.05.

The data presented in the table indicate the effectiveness of solving search problems in a visual-figurative form (the "Game of Five" method) associated with mentally moving numbers across the playing field.

It is important to note that the effectiveness of solving problems among schoolchildren of the first contingent (studied at school according to the D. B. Elkonin - V. V. Davydov program) differs from the effectiveness of schoolchildren of the second contingent according to the traditional primary education program.

Thus, all problems (training Nos. 1 - 3, basic three-move Nos. 4 - 7, basic four-move Nos. 8 - 11) in the first contingent were successfully solved by 74.1% of students (i.e. slightly less than three quarters of all children in this contingent), and in the second contingent - 53.6% (i.e. slightly more than half of all children), - mathematical processing showed that the difference in the noted indicators is statistically significant (at $p < 0.05$).

In accordance with the data characterizing the success of the solution of all 11 proposed problems by schoolchildren of both contingents, the data characterizing the success of the solution of the first seven problems differ: three training and four main three-move problems.

Thus, in the first contingent, the success of solving problems 1 - 7 was less than in the second contingent, respectively: 24.1% and 42.4% (the difference in the noted indicators is statistically insignificant).

In general, the results obtained in group experiments conducted on the material of the "Game of Five" methodology showed that fourth-graders who studied according to the D. B. Elkonin - V. V. Davydov program coped with the proposed problems significantly more successfully than their peers who studied according to the traditional primary education program.

4. Conclusion.

The conducted experimental work was aimed at studying the issue of the nature of the connection between the content of the primary school curriculum and the use by children of generalized and non-generalized methods for achieving the desired result when solving problems.

A total of 110 fourth-graders participated in the study, some of whom (54 people) studied according to the D. B. Elkonin - V. V. Davydov program, others (56 people) studied according to the traditional primary education program.

The data obtained in the study allow us to conclude that training according to the D. B. Elkonin - V. V. Davydov program to a greater extent contributes to the development of children's general (generalized), theoretical method for solving search problems (in particular, spatial-combinatorial problems of the "Game of Five" technique) than training according to the traditional primary education program.

The scientific significance of the work carried out is associated with the fact that as a result of the experiments, new knowledge was obtained that reveals the possibilities of mastering the theoretical method of solving problems by younger students. This knowledge complements the ideas of developmental and educational psychology about the nature of the development of intellectual activity during the education of children in elementary grades of school.

In the future, it is planned to conduct similar studies with students of the third and second grades in order to determine the content of differences in the methods of solving problems associated with learning according to different programs - D. B. Elkonin - V. V. Davydov and the traditional program of primary education.

At the same time, in future studies it is necessary to use other methods, including search tasks (for example, plot-logical tasks), in order to more fully characterize the nature of differences in younger students in mastering effective methods of solving problems.

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