POSSIBILITIES OF THE "MOVEMENT" METHODOLOGY IN DETERMINING THE FEATURES OF SOLVING PROBLEMS AMONG PRIMARY SCHOOL STUDENTS

A.Z. Zak, *Leading Researcher*
Psychological Institute of Russian Academy of Education
(Russia, Moscow)

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Abstract. *The article describes the content of the study aimed at creating and testing the "Movement" methodology, which includes tasks that are solved in a visual-figurative form. In these tasks, an imaginary character moves around the playing field based on certain rules. It is required to find a route for moving this character from one point of the playing field to another in the required number of actions. The methodology is intended for younger students in order to determine how the tasks are solved: general, theoretical or private, empirical. Individual experiments with fourth-graders showed the wide possibilities of the methodology in distinguishing children by the method of solution.*

Keywords: *fourth-graders, "Movement" methodology, theoretical and empirical approaches to problem solving.*

1. Introduction. The Federal State Educational Standard of the NEO [6] states that the study of the primary school curriculum by younger students creates conditions not only for children to acquire knowledge, skills and abilities in basic academic subjects, but also opens up wide opportunities for children to form universal educational activities of various character: cognitive, regulatory. communicative, personal and sign-symbolic.

The subject of our study was the cognitive competence associated with the development of ways to solve problems of a search character. The purpose of the study was to develop a methodology that allows determining the formation of the named cognitive competence among primary school graduates.

In understanding the characteristics of ways to solve problems of a search nature, we relied on the concept of two types of cognitive activity developed in the dialectical theory of knowledge (see, for example, [8]) and implemented in the works of V.V. Davydov (see, for example, [1]).

According to these ideas, a person's knowledge of the surrounding world can be aimed at reflecting the internal connections of objects and phenomena (theoretical, meaningful, reasonable knowledge) and at reflecting their external connections (empirical, formal, rational knowledge).

In the first case, cognitive activity is effective, since its result is an understanding of the causes of changes in objects of knowledge. In the second case, cognitive activity is ineffective, since its result is only a description and ordering of the observed features of the change in cognizable objects.

Based on these ideas about the two types of cognition, it was accepted (see, for example, [1-4]) that the development by a person of ways to solve problems of a search nature in one case involves the allocation of significant relations in conditions for achieving the desired result, otherwise such development is not related to the disclosure of significant relationships. In the first case, the methods used can be characterized as meaningful, in the second case – as formal.

Achieving a cognitive meta-subject result associated with the development by schoolchildren in the course of learning how to solve problems of a search nature involves the formation of a mental action of analysis, which is associated with the analysis of conditions for obtaining the desired result.

In some cases, such an analysis is implemented as a formal analysis, which only divides the proposed conditions into separate data - this is typical for a non-generalized, empirical method of solving problems of a search nature (see, for example, [1-4]).

In other cases, the analysis of conditions is connected not only with the selection of data and their relationships, but also, most importantly, with the clarification of their role in a successful decision: which of them is essential and necessary, and which is insignificant and accidental. This is a meaningful, clarifying analysis, serving as a condition for a generalized, meaningful way to solve search problems.

The development of generalized ways to achieve the desired result is characterized by the ability to carry out a meaningful analysis of the proposed conditions, associated with the allocation of significant data relationships. As a result, all problems of this class are successfully solved. The fact of unsuccessful solution of one or more of them indicates the absence of a meaningful analysis and, therefore, the presence of a non-generalized way to solve the proposed problems.

2. Materials and methods

On the basis of ideas about the originality of different approaches to the analysis of the conditions of the proposed problems related to the same class, and the different ways of solving them associated with these approaches, requirements were developed for an experimental situation designed to determine the nature (generalized or non-generalized) of the method of action when achieving the required result.

First, the subject must be offered not one, but several problems to solve. Secondly, these problems must have a common principle of solution. Thirdly, their conditions must differ in external, directly observable features.

Compliance with the above requirements makes it possible to determine when children use meaningful analysis in solving problems of the same type and when children use formal analysis. As a result, it will be possible to characterize the formation of cognitive metasubject competence associated with the development of methods for solving search problems.

2.1. Characteristics of the "Movement" technique

In accordance with the specified requirements, the "Movement" methodology was developed. The meaning of the tasks of this technique is to find a way to move an imaginary character (“Rooster”) from one cell of the playing field to another according to the given rules and in the required number of steps (Fig.).

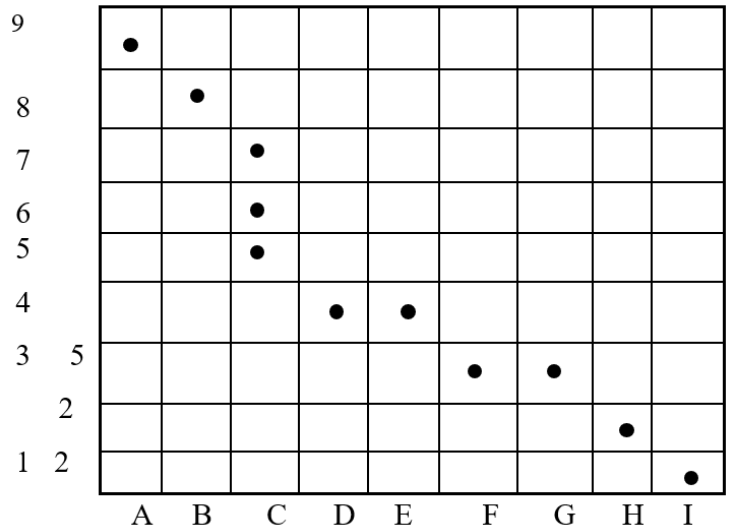

Fig. Solution of a multi-pass problem

Moving the "Rooster" on the cells of the playing field is subject to the following rules. The "Rooster" can move to neighboring cells either directly (i.e. horizontally or vertically) or obliquely (i.e. diagonally). At the same time, he can take no more than two identical steps in a row. This means that after two steps straight he takes a step obliquely and after two steps obliquely – a step straight.

Thus, “a rooster can alternate steps straight and oblique in different ways: a step straight - a step oblique, a step straight - two steps oblique, two steps straight - a step oblique, two steps straight - two steps oblique. There will be four options for alternating steps if you first take steps obliquely: a step obliquely - a step straight, a step obliquely - two steps straight, two steps obliquely - a step straight, two steps obliquely - two steps straight.

Here is how, for example, such a multi-pass task: how can a "rooster" get from cell A9 to cell I1 (Fig. 1) in 10 steps? Solution: first, the “rooster” took two steps obliquely A9 - B8 - C7, then two straight steps C7 - C6 - C5, a step obliquely C5 - D4, a step straight D4 - E4, a step obliquely E4 - F3, a step straight F3 - G3 and two steps obliquely G3 - H2 - I1.

2.2. Types of tasks of the "Movement" technique

Based on the rules for moving the "rooster", three types of problems were developed: multivariate, univariant and unsolvable.

In multivariate problems, the solution has several successful sequences of steps. For example, a task where you need to get from cell B2 to cell D2 in three steps has six successful solutions: 1) B2 - C2 - D3 - E2; 2) B2 - C3 - D2 - E2; 3) B2 - C3 - D3 - E2; 4) B2 - C2 - D1 - E2; 5) B2 - C1 - D2 - E2; 6) B2 - C1 - D1 - E2.

In single-variant problems, the solution has only one successful sequence of steps. For example, a task where you need to get from cell A4 to cell D9 in five steps is solved as follows: A4 - B5 - C6 - C7 - D8 - E9.

In unsolvable problems, there is no satisfactory solution provided that the rules and the required number of steps are observed. For example, a task where you need to get from cell A1 to cell D4 in three moves. The fact is that the most probable sequences of three steps end in cells C4 or D3. And to get to cell D4, you need to take the fourth step.

2.3. Content of individual experiments

To test the "Movement" methodology, individual experiments were organized with fourth-grade students. The meaning of the experiments was to reveal the possibilities of the methodology in differentiating children according to the way they solve problems.

The first task was a practice task, so that the children tried to use the rules for moving the “rooster”. To do this, a multivariate task was proposed in three steps: C1 - E4, which has three options for a successful solution: 1) C1 - C2 - D3 - E4; 2) C1 - D2 - D3 - E4; 3) C1 - D2 - D3 - E4.

The second, third, fourth and fifth tasks were the main ones. They were proposed to determine the type of analysis of the conditions of problems - theoretical, meaningful, associated with the allocation of significant relations, or formal, empirical, when significant relations are not distinguished. Single-variant problems were used as the main ones, which, despite the external difference in their specific conditions, had a common principle of solution.

Each problem had to be solved in eight steps: in the first problem it was required to find the path from A1 to G9, in the second - from I2 to A8, in the third - from I9 to A3, in the fourth - from B9 to H1.

The tasks differ in external features of the conditions (different initial and final cells), so that the specific steps of the "rooster" in the method of solving the previous task are not used in the next one.

The general principle for solving all problems is that in each problem the sequence of eight moves includes six oblique moves and two straight steps: the first two steps and the last two steps must be performed obliquely.

2.3.1. Conducting individual experiments

The experiment with each of the 53 fourth-grade schoolchildren was carried out as follows. The child is offered a sheet of paper on which a square cellular playing field was drawn (Fig. 1).

Then the experimenter said: “Today we will solve interesting problems. Here, a square of cells is drawn on the sheet. Each cell in it has its own name from a letter and a number. For example, this cell, - (the experimenter points to the lower left corner), - is called A1. In this corner, - (the lower right corner is indicated), - there will be cell I1. Here there will be cell A9, - (indicates the upper left corner), and here - I9, - (indicates the upper right corner). Now I will point to different cells of the square, and you will say their names.

Along with this verification option, the experimenter also uses another one: he names different cells, and the student shows them on the playing field. After it becomes clear that the child confidently operates with the names of the cells of the playing field, he is told: “A magic“ cock ”walks along the cells of this square. He steps only into neighboring cells: up, to the side or down. And never jumps over the cage. For example, from cell B3 he can go directly to cell B2, or B4, or A3, or C3 with one step.

In addition, the "rooster" steps into neighboring cells and obliquely. For example, from cell B3 he can get in one step obliquely into cell C4, or C2, or A4, or A2.

The main rule of steps is that he can do no more than two identical steps in a row. If he took two steps straight, then he must take a step obliquely. For example, if he went from A1 to A2 and then to A3, then after that, he must take the third step obliquely - either to B4 or B2.

And if the "rooster" took two steps in a row obliquely, then he must then take a step straight. For example, if from A1 he first went to B2 and then to A3, then he must take the third step directly: to cell A4 or to cell B3.

Of course, the "rooster" can alternate one step at a time: a step straight - a step obliquely - a step straight - a step obliquely, for example: A1 - A2 - B3 - C3 - D4 - E4.

He can also alternate one step and two steps, for example: straight step - two steps obliquely (A1 - A2 - B3 - C4) or oblique step - two steps straight (A1 - B2 - B3 - B4). But the main thing is that you cannot take three identical steps in a row.

Let's now practice the "rooster" steps. How can he get from cell A1 to I9? ... What could be the first step?... What is the second step?...” In the course of a joint discussion, the children suggest different steps of the "goose" on the way to the specified goal, and the experimenter recalls the basic rule of its movements - "no more than two identical steps in a row."

Then the experimenter says: “Let's solve such a problem. From cell B3 "" took three steps and hit the cell E2. Name the cells he walked on.

That's right, he could first step into B3, then to D3, and then to E2. Write down this solution using the names of these cells,” – the child independently writes down a solution of three moves as follows: 1) C3, 2) D3, 3) E2.

Then the experimenter offered to solve a control training problem, where in three moves it was required to find a way from cell B1 to cell E4.

After solving this problem, the subject was asked to solve four main single-variant problems. In each problem, it was required to find eight moves. This was given 20 minutes.

3. Results

3.1. Distribution of children according to the method of solving problems

Experiments with subjects made it possible to establish the following effective characteristics of solving four main tasks.

It turned out that 60.4% (32 out of 53 people) solved the problems with the help of a theoretical, meaningful analysis and found a general principle for solving them.

At the same time, observations of the actions of these children made it possible to distinguish two groups. The first group, T-1, included "theorists" who discovered the general principle of solution on the basis of the first problem. The second group, T-2, included "theorists" who discovered the general principle of solution on the basis of the second problem. The T-1 group consisted of 43.7% of all "theorists", the T-2 group, respectively: 56.6%.

The rest of the subjects (39.6%) were unable to perform theoretical analysis and find a general principle of solution when solving the main problems. They can be conditionally called "empiricists".

Observations of the actions of "empiricists" made it possible to distinguish three groups of subjects. The first group, E-1 (28.5%), are “empiricists” who have solved two problems correctly. The second group, E-2 (47.7%), are “empiricists” who have solved one problem correctly. The third group, E-3 (23.8%), are “empiricists” who have not solved a single main problem.

3.2. Features of solving problems by children of different groups

Along with the productive characteristics of problem solving noted above, the data of

observations of the process of solving problems by children of the above five groups are of great importance: T-1, T-2, E-1, E-2 and E-3.

Differences between these groups of subjects already took place when solving the training problem. Thus, the subjects of groups T-1 and T-2 not only used one solution, but also offered two more options for successfully solving this problem. Most often, these were, firstly, the option when the first two moves were oblique, and the third move was straight (i.e. C1 - D2 – E3 - E4), and, secondly, the options when the first move was straight, and the second and third are oblique (i.e., C1 - C2 - D3 - E4).

When asked by the experimenter whether there were still possible options for successfully solving this problem, the subjects easily found the third variant of the sequence of three moves (from C1 to E4): in this case, moves of different types simply alternated (i.e., the first move was obliquely, the second is straight, the third is oblique: C1 - D2 - D3 - E4).

The subjects of the E-1 group, as well as the "theorists", could independently find two options for solving the training problem. However, unlike the "theorists", they found somewhat different options.

So, usually, as the first option, they found a sequence of three moves, in which moves of different types alternated like this: oblique, straight, oblique (C1 - D2 - D3 - E4). As a second option, they suggested a three-move sequence where the first move was straight and the other two were oblique (i.e., C1 - C2 - D3 - E4).

At the same time, when the experimenter asked if there were still possible options for successfully solving this problem, the subjects of the E-1 group most often found it difficult to answer and usually did not find a third option, when the sequence of three moves included oblique steps as the first two, and as the third - step straight (i.e. B1 - D2 - E3 - E4).

The subjects of the E-2 group, in contrast to the subjects of the E-1 group, could not independently find any two variants of a successful sequence of three moves in the training problem. Most often, they offered such a variant, which was associated with a sequence of three moves, in which moves of different types alternated as follows: oblique - straight - oblique (i.e. C1 - D2 - D3 - E4).

When asked by the experimenter whether there were still possible options for successfully solving this problem, the subjects of this group could find with great difficulty only one more option: usually this option was associated with a sequence of three moves, in which the first move was straight, and the other two were obliquely (i.e. C1 - C2 - D3 - E4).

The subjects of the E-3 group, just like the subjects of the previous group (i.e., the E-2 group), were able to independently find only one variant of the sequence of three moves in the training task and, just like the subjects of the E-group, 2, this variant was most often associated with a sequence of three moves, where different types of steps alternated as follows: C1 - D2 - D3 - E4.

When asked by the experimenter about whether there are still possible options for successfully solving this problem, the subjects of this group could not find any other option.

Even more significant differences in procedural characteristics between the groups of subjects T-1, T-2, E-1, E-2, E-3 were observed when solving four main tasks, each of which, as noted, had one variant of a successful solution, associated with a sequence of eight moves, where 1 and 2, 4 and 5, 7 and 8 moves were performed obliquely, and 3 and 6 straight.

3.3. Characteristics of the solution of problem 1 by subjects of different groups

3.3.1. Features of the behavior of the subjects of the T-1 group

Determination of the location of the initial and final cells was performed by the subjects of this group clearly and quickly. At the same time, they, as a rule, first touched cell A1 with a pen, then cell I9. Then active gaze movements were observed from cell A1 to cell I9 for some time. This testified, in our opinion, that the children tried to remember the extreme points of the desired route.

Then one part of the children of the T-1 group performed three trial attempts of the solution, and the other part of the children of

the same group performed four trial attempts. For those children who limited themselves to three attempts, of which the third was successful, it was characteristic that the first attempt was completed. This means that the path from the start cell to the end cell was presented. However, due to the fact that not eight, but nine moves were made, this attempt was unsuccessful.

The second attempt was then, as a rule, incomplete. This means that the children usually performed four or five moves, after which it became clear to them that it would be impossible to meet eight moves.

The third attempt, like the first one, was completed: here the children demonstrated a sequence of eight moves, with the help of which one can get from cell A1 to cell I9.

Those children in whom the fourth trial attempt was successful are characterized by some differences from the previous part of the children of the T-1 group. They expressed themselves in the fact that their second trial attempt was also completed and also unsuccessful, since it included nine moves. The third attempt was incomplete, similar to the second attempt for the subjects of the first part of the T-1 group.

3.3.2. Features of the behavior of the subjects of the T-2 group

The behavior of the subjects of the T-2 group in the process of solving problem 1 differed from the behavior of the subjects of the T-1 group. Thus, the determination of the location of the initial and final cells was performed by the subjects of the T-2 group less clearly and less quickly than it happened in the subjects of the T-1 group. Having fixed the location of these cells, first by touching them with a pen and then with their eyes, the subjects of the T-2 group, like the subjects of the T-1 group, (although not as long as the subjects of the T-1 groups) measured the distance from A1 to I9 with their eyes.

Then one part of the children of the T-2 group (the first subgroup of T-2) performed four trial attempts of the solution before the fifth attempt became successful. The other part of the children (the second subgroup T-2) performed five trial attempts before the sixth attempt was successful. The unsuccessful nature of the attempts that preceded the one where the problem was solved correctly was due to the fact that the children, in order to get from A1 to I9, performed not eight, but nine moves.

It should be noted that the attempt immediately preceding the final (successful) one was always incomplete: in the course of its implementation, usually four or five moves were performed. And all the initial trial attempts (first, second and third) in the first subgroup T-2 and (first - fourth) in the second subgroup T-2 were completed.

3.3.3. Features of the behavior of the subjects of the E-1 group

The behavior of the subjects of group E-1 in the process of solving the first main problem differed from the behavior of the "theoreticians". As noted earlier, the subjects of the E-1 groups, unlike the subjects of the T-1 and T-2 groups, could not solve all the main tasks successfully: they successfully solved only two of the four main tasks - the first and fourth or the first and third or second and fourth. Thus, in some cases, the subjects of group E-1 coped with the first task, without solving the second, in other cases, on the contrary, they could not cope with the first task, but then correctly solved the second task.

It should be noted that the successful solution of any task - the first, second, third or fourth - occurred in the subjects of group E-1 randomly. This follows from the observational data on the process of solving problems, according to which the behavior of the subjects of this group did not differ much in situations of successful and unsuccessful solution of the same problem.

The total number of trial attempts in the E-1 group, regardless of whether the solution was successful or unsuccessful, reached seven to eight. All attempts were completed, i.e. children each time "passed" the path from the initial cell to the final one. It is important to note that the initial attempts - usually from the first to the fifth - as the first move (or even the first two moves) had a step straight, although sometimes there was a step obliquely as the first move. The last three or four attempts had as a first move, as a rule, a step obliquely.

It should be noted that in the trial attempts of subjects E-1, there were a variety of op-

tions for the ratio of steps of different types: alternating steps one at a time (oblique - straight - oblique - straight or, conversely, straight - oblique - straight - oblique), alternating steps two and one (straight - straight - oblique - oblique), alternating steps two and two (oblique - oblique - straight - straight or straight - straight - oblique - oblique).

Thus, the analysis of the process of solving problem 1 by the subjects of the E-1 group shows significant differences in the actions of the subjects of this group from the actions of the subjects of the T-1 and T-2 groups, who successfully solved all four main tasks.

3.3.4. Features of the behavior of the subjects of the E-2 and E-3 groups

Observations of the actions of the subjects of groups E-2 and E-3 in solving problem 1 show their significant similarity with the actions of the subjects of group E-1. As well as the subjects of the E-1 groups, the subjects of the E-2 and E-3 groups carried out a significant number of trial attempts, seven, eight, and sometimes even nine, all attempts were completed, as the first move and often the first two moves, a straight step was used, the ratios of steps of different types were very diverse: oblique - straight - oblique, straight - oblique, straight - oblique - oblique,

In general, consideration of the characteristics of the actions of the test groups E-1, E-2 and E-3 shows a significant commonality of the behavior of these children in the course of solving task 1 and the fundamental difference between such behavior and the behavior of the test groups T-1 and T-2 when solving the same task.

Observations of children's behavior show that the differences noted above persist when solving the other three main tasks.

4. Conclusion

This study was devoted to solving an important problem for educational psychology: the development of a methodology designed to diagnose the method of solving problems in younger students.

With two classes of primary school graduates, individual experiments were carried out using the new method of "Movement". As a result, it was shown that solving the problems of this technique allows differentiating children according to the method of action to achieve the desired result.

Some children solved problems in a general way, which is associated with a meaningful analysis of the conditions of the problems in order to highlight the essential relationships in their conditions and discover the principle of solving a number of similar problems. This is the theoretical way.

Other children solved problems in a private way, which is associated with a formal analysis of the conditions of the problems, not aimed at highlighting essential relations in the conditions of the problems and at searching for the principle of solving a number of similar problems. This is the empirical way.

Concluding the consideration of the results of the development and testing of the "Movement" methodology, designed to determine the formation of cognitive competence associated with the development of methods for solving problems, it is necessary to note the new facts obtained in the study.

First, observations of the actions of students who carry out meaningful analysis in solving problems made it possible for the first time to identify two groups of children: in one group, subjects identify a general principle of solution when analyzing the content of the first task and when analyzing the content of the second task.

Secondly. Observations of the actions of students who carry out formal analysis in solving problems made it possible to identify three groups of children: those who solved two problems, those who solved one problem, and those who did not solve a single problem.

The results obtained in the study give reason to believe that the developed methodology "Movement" will allow more accurately than before to determine the formation of cognitive universal learning activities in younger students (in particular, among primary school graduates) related to the development of ways for solving search problems by children.

It should be noted that the knowledge obtained in the study expands the ideas of developmental and educational psychology about the intellectual capabilities of primary school graduates.

The established facts will allow the compilers of curricula to make them more effective for creating conditions for the intellectual development of younger students.

In further research, it is planned to study the possibilities of the "Movement" methodology to distinguish between younger students by the method of solving problems in experiments with students from other grades of primary school - third, second and first.

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ВОЗМОЖНОСТИ МЕТОДИКИ «ПЕРЕМЕЩЕНИЕ» В ОПРЕДЕЛЕНИИ ОСОБЕННОСТЕЙ РЕШЕНИЯ ЗАДАЧ У ШКОЛЬНИКОВ НАЧАЛЬНЫХ КЛАССОВ

А.З. Зак, *ведущий научный сотрудник*
Психологический институт РАО
(Россия. г. Москва)

Аннотация. *В статье излагается содержание исследования, направленного на создание и опробование методики «Перемещение», включающей задачи, решаемые в наглядно-образной форме. В этих задачах воображаемый персонаж перемещается по игровому полю на основе определенных правил. Требуется найти маршрут перемещения этого персонажа от одного пункта игрового поля до другого за нужное число действий. Методика предназначена для младших школьников с тем, чтобы определить, каким способом решаются задачи: общим, теоретическим или частным, эмпирическим. Индивидуальные эксперименты с четвероклассниками показали широкие возможности методики в различении детей по способу решения.*

Ключевые слова: *четвероклассники, методика «Перемещение», теоретический и эмпирический подходы к решению задач.*