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Developing mental actions in 9.5-10-year-old children

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Abstract

The acceleration of scientific and technological progress requires an increase in the level of professional qualifications of specialists. This leads to the complication of educational programs at all levels of education, including the primary school. Mastering complex knowledge, skills and activities presupposes a high level of development of thinking skills. Insufficient development of these skills makes it difficult for children to master the concepts developed in modern science. More intensive development of thinking in primary school is realised in two ways – through changing the forms of education and through optimising its content. The first approach can be conditionally qualified as psychological, since it is not associated with a change in the content of information that is transmitted to students, but is aimed at changing the conditions for its transmission. The second approach can be considered pedagogical, since it is associated with a change in the content of the transmitted information. Research related to the development of methods of teaching thinking belongs to the first approach. The study aims to determine the conditions for the development of mental actions in 9.5-10-year-old children. The author's program "Development 1" acts as such a condition. This program includes 28 types of non-standard tasks of non-educational content. The control group consisted of 118 children, the experimental group – 122. The children of this group participated in 28 group sessions (from September to May, one session per week). The research shows that the program "Development 1" significantly contributes to the development of mental actions in 9.5-10-year-old children.

For citation

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Keywords

9.5-10-year-old children, development, mental actions, development of mental actions, developmental program "Development 1".

Introduction

At the beginning of the 21st century, a number of studies were carried out on the methods, forms and programs for the development of mental actions in schoolchildren.

P. Adey characterises the principles and methods for developing programs aimed at developing thinking in 4-11-year-old children. At the same time, methods of implementing the developed programs in combination with standard programs of a modern school are disclosed in detail [Adey, 2008].

There is research on the developmental program in the teaching of thinking in primary school children. On the one hand, the researchers note a marked improvement in the cognitive abilities of children, which has a positive effect on their social and communicative development. On the other hand, the application of these programs helped to improve the professional training of teachers [Dewey, Bento, 2009].

A group of scientists studied various conditions for stimulating intelligence in children in general, as well as such important components such as inferences based on abstract material and deductive reasoning on educational material. At the same time, different sides of self-regulation were controlled, which took place in the behaviour of children. It was found that the positive changes that were the result of using the PAEA method were not only maintained one year after the intervention, but generally increased [De Acedo Lizarraga et al., 2009].

Important facts were obtained in one of the studies. The program for the development of mental actions was analysed, which was realised in the conditions of standard school education. A feature of this program was that children were asked to solve mental problems of a search nature [McGuinness et al., www].

S. Trickey and K.J. Topping critically reviewed a number of studies in which the Philosophy for Children program developed by the famous American philosopher Matthew Lipman was used in the work with children of primary school age. It was noted that this program promotes both the development of thinking in general and the improvement of mental actions associated with consistent reasoning and detailed argumentation of the declared points of view [Trickey, Topping, 2004].

B. Lucas and G. Claxton examined the main areas of research in the development of the intelligence of children, characterised such different types of intelligence as social, practical, strategic, intuitive and many others. They analysed in detail, in a form accessible to teachers, important means of effective practical pedagogical activity, in particular, its tools and templates. Such an analysis is necessary so that teachers can meaningfully include work on the thinking of students in teaching [Lucas, Claxton, 2010].

There is an interesting approach, which critically analyses such serious factors in the development of the intelligence of children as their belonging to a particular social group, the peculiarities of the environment in which the child lives, the content of inherited properties and qualities. At the same time, the researchers consider the relationship between the development of the intelligence of children with the peculiarities of the regulation of their behaviour in learning, the properties of working memory, as well as with cognitive and metacognitive skills [Nisbett et al., 2012].

There is research dealing with an important direction in the development of cognitive skills related to teaching mathematics. The results of the implementation of the project, which stimulated the development of cognitive skills in the framework of the study of mathematics by schoolchildren, were analysed. Based on experimental data obtained over a number of years, the productivity of this approach has been noted [Shayer, Adhami, 2007].

R. Swartz and C. McGuinness investigated the relationship between the principles and methods of

improving thinking skills, as well as methods for assessing this activity with the development of a standard school curriculum. The authors consider in detail the various possibilities of combining teaching thinking, associated with activities for the development of mental actions, with the assimilation of the content of specific academic subjects by children [Swartz, McGuinness, www].

The possibilities of sequential formation of thinking skills in schoolchildren are studied by using the material of the previously developed thirteen categories of thinking skills (from relatively simple to relatively complex). It is important to note that the authors, in parallel with the improvement of thinking skills, propose in the conditions of real application to master essential language skills, thereby combining the stimulation of the cognitive and linguistic development of children [Puchta, Williams, 2011].

Consideration of studies related to different approaches to the study of the conditions for development of mental actions allows us to note that, in general, programs created on the material of academic subjects are used. (Remember the theory of activity – create conditions for the formation.)

We believe that for such a study it is advisable to use search problems of non-educational content. In this case, on the one hand, more favourable conditions are created for the development of mental actions. This is due to the fact that in solving problems of non-educational content, school knowledge (in contrast to solving problems of educational content) will not determine the success of search actions.

On the other hand, children with insufficient academic success will have opportunities to act more confidently than when solving educational problems. Children enter into new experiences, which (unlike the experience of mastering academic disciplines) are not associated with failure. Their self-esteem in this case will be higher than when solving school problems.

The main part

Our research was aimed at development of mental actions in 9.5-10-year-old children. The aim of the study was to determine the conditions for the noted development. The null hypothesis of the study was that 28 lessons with pupils of the experimental group under the program "Development 1" for nine months will not provide a noticeable development of mental actions. The alternative hypothesis, on the contrary, was that the marked activities would significantly contribute to the development of mental actions. In this case, after nine months, the results of the experimental group will be statistically significantly different from the results of the control group. This statement is based on the results of observations of the actions of children with different intellectual training in preliminary individual experiments [Zak, 2004]. It was found that children, on their own or with little help, successfully solved the simplest variants of problems of various types from the Development 1 program.

The study included three stages. At the first stage, two groups of students (control – 118 children and experimental – 122) solved several search problems to assess the level of improvement of mental skills. At the second stage, during the academic year (September – May), 28 lessons were conducted in the experimental group (one lesson per week) in accordance with the Development 1 program. At the third stage, the children of both groups again solved the same search problems as at the first stage.

The program "Development 1" is designed to conduct 28 lessons on the material of 28 types of non-standard tasks of non-educational content: 8 types of plot-logic tasks, 5 types of comparative tasks, where it is required to compare schematically presented objects, 7 types of spatial tasks, 8 types of routing tasks related to movements on the playing field according to certain rules. At each lesson, the children solved only one type of problem.

Lesson 1: routing tasks (type 1). Lesson 2: plot-logic problems (type 1). Lesson 3: spatial problems

(type 1). Lesson 4: routing tasks (type 2). Lesson 5: comparative problems (type 1). Lesson 6: plot-logic problems (type 2). Lesson 7: spatial problems (type 2). Lesson 8: route problems (type 3). Lesson 9: plot-logic problems (type 3). Lesson 10: comparative problems (type 2). Lesson 11: spatial problems (type 3). Lesson 12: routing tasks (type 4). Lesson 13: plot-logic problems (type 4). Lesson 14: spatial problems (type 4). Lesson 15: comparative problems (type 3). Lesson 16: routing tasks (type 5). Lesson 17: plot-logic problems (type 5). Lesson 18: spatial problems (type 5). Lesson 19: routing problems (type 6). Lesson 20: comparative problems (type 4). Lesson 21: plot-logic problems (type 6). Lesson 22: routing tasks (type 7). Lesson 23: spatial problems (type 6). Lesson 24: plot-logic problems (type 7). Lesson 25: comparative problems (type 5). Lesson 26: routing tasks (type 8). Lesson 27: spatial problems (type 7). Lesson 28: plot-logic problems (type 8).

8 types of plot-logic tasks are characterised as follows.

Type 1, e. g.: “Dima, Lenya and Borya swam across the river. Dima swam faster than Lenya. Lenya swam faster than Borya. Who sailed the fastest?”

Type 2, e. g.: “Words GAZ, YEAR, ROD of different colors. The blue and pink words have the same first letter, pink and red the second letter. Which word is blue?”

Type 3, e. g.: “Anna and Lena are of different ages. In many years, Anna will be a little older than Lena is now. Which of the girls is younger?”

Type 4, e. g.: “Petya, Alla and Sveta sent letters: two to Ufa, one to Samara. Petya and Alla, Alla and Sveta were sent to different cities. Where did Petya send the letter?”

Type 5, e. g.: “The words DREAM, AGE and VOL were written in blue, red and grey paint. The blue word is to the left of the red, the grey one to the right of the red. What colour is the word AGE?”

Type 6, e. g.: “Dima and Katya had cubes with letters. First, Dima composed the word POT. Then he rearranged the letters and got the word TOP. Katya first composed the word ERA, and then rearranged the letters, like Dima. What word did Katya get?”

Type 7, e. g.: “There were three cats – grey, white and black: one in the room, one in the hall, one in the attic. In the morning they fed either a black cat, or in the attic, in the evening – either in the attic, or a white one. Where was the grey cat?”

Type 8, e. g.: “Ira, Ella and Anya received a doll each. One doll was in a red long-sleeved dress, another in a red short-sleeved dress, and the third in a green long-sleeved dress. Ira and Ella's dolls were in dresses of the same colour, Ella's and Anya's dolls had the same sleeves. Who had the doll in the long-sleeved red dress?”

5 types of comparative problems (for comparison of schematically represented objects) are characterised as follows.

Figure 1. Shapes

Type 1, e. g.: "Consider figures 2, 3, 6. Which figure has a shape like figure 6?"

Type 2, e. g.: "Consider figures 1, 3, 5. Which figure has the same feature with figure 5?"

Type 3, e. g.: "Consider figures 1, 4, 5. Which figure, 4 or 5, has more similar features with figure 1?"

Type 4, e. g.: "Consider shapes 2, 3, 6. Which shape, 2 or 3, has a shape like shape 6, and a dark

pattern like shape 1?"

Type 5, e. g.: "Consider figures 1, 3, 6. Which figure, 1 or 3, has one identical feature with figure 1 and one with figure 6?"

7 types of spatial problems are characterised as follows.

Type 1, e. g.: “How the arrangement of letters | C | | P | change in two steps to get the layout | P | C | | ?” Rule: one action is to move any letter to an empty space. Solution: (1) | C | | P | --- | | C | P | , (2) | | C | P | --- | P | C | | or | C | | P | --- | | C | P | --- | P | C | | : in the first action the letter “C” is moved to an empty space, in the second action the letter “P”.

Type 2, e. g.: “How the arrangement of letters | P | P | C | | change in two steps so that you get the arrangement of numbers | 7 | 4 | | 4 | ?” Rule: 1) one action is to move any letter to an empty space; 2) the same letters must be located in the same way as the same numbers. Solution: | P | P | C | | --- | | P | C | P | --- | C | P | | P |.

Type 3, e. g.: “How can you change the location of the letters in two steps so that the location is obtained?” Rule: one action is to move any letter to an empty space. Solution:

Type 4, e. g.: “How can you change the location of the letters in two steps so that the location is obtained?” Rule: the same letters must be placed in the same way as the same numbers. Solution:

Type 5, e. g.: "How to change the arrangement of letters: P M K in two steps so that you get the arrangement of K P M?" Rule: one action is the simultaneous exchange of places of two letters. Solution: P M K --- P K M --- K P M: first swap the letters M and K, then the letters P and K.

Type 6, e. g.: "How to change the arrangement of letters: P P M K in two steps so that the arrangement of the numbers 6 8 5 5 is obtained?" Solution: P M M K --- P M K M --- P K M M.

Type 7, e. g.: “How can the arrangement of letters | B | | H | | L | change in two steps so that you get the location | | H | N | L | | ?” Solution: | B | | N | | L | --- | | B | N | | L | --- | | B | N | L | |.

8 types of routing problems associated with the movement of imaginary characters according to certain rules are characteried by the following.

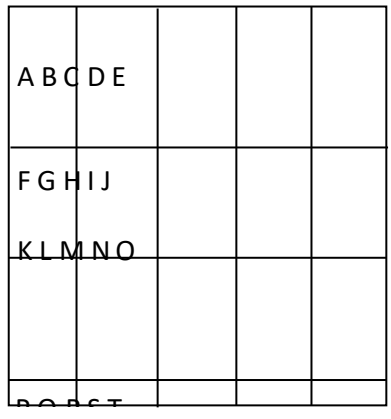

Figure 2. Playing field

Type 1, e. g.: "What two steps did the duck take to get from L to S?" Rule: 1) the imaginary character "Duck" moves letter by letter in the cells of this square; 2) features of her movements: (a) steps straight, i. e. to an adjacent cell vertically (e. g.: from cell M to cell H or cell R) or horizontally (e. g., from cell M to cell L or N); (b) the steps are oblique, i. e. diagonally, e. g.: from cell M to cell G

or I or S or Q; 3) the duck cannot make two identical steps (two steps straight or two steps obliquely) in a row. Solution: L – R – S.

Type 2, e. g.: "What two jumps did the hare make to get from K to E?" Rule: 1) an imaginary character "Hare" moves letter by letter in the cells of this square; 2) features of his movements: (a) jumping straight, i. e. through the cell vertically (e. g.: from cell M to cell C or cell W) or horizontally (e. g., from cell M to cell K or O); (b) jumping obliquely, i. e. diagonally, e. g.: from cell M to cell E or A or U or Y; 3) the hare cannot make two identical jumps (two jumps straight or two jumps obliquely) in a row. Solution: K – M – E.

Type 3, e. g.: "What two movements did the duck and the hare make to get from H to U?" Rule: 1) the duck and the hare move in turn; 2) the duck walks only straight; 3) the hare jumps only obliquely, e. g.: duck: M – L, hare: L – X, duck: X – W, hare: W – O. Solution: H – M – U.

Type 4, e. g.: "What two movements did the duck and the hare make to get from J to W?" Rule: 1) the duck and the hare move in turn; 2) the duck walks only obliquely; 3) the hare only jumps straight, e. g.: duck: I – H, hare: H – R, duck: R – V, hare: V – X. Solution: J – M – W.

Type 5, e. g.: "What three movements did the duck and the hare make to get from D to K?" Rule: 1) the duck and the hare move in turn; 2) the duck walks straight and obliquely; 3) the hare only jumps straight, e.g.: duck: T – Y, hare: Y – W, duck: W – Q, hare: Q – G, hare: G – I, duck: I – J, hare: J – T. Solution: D – H – F – K.

Type 6, e. g.: "What three movements did the duck and the hare make to get from E to X?" Rule: 1) the duck and the hare move in turn; 2) the duck walks straight and obliquely; 3) the hare only jumps obliquely, e. g.: duck: C – H, hare: H – P, duck: P – V, hare: V – N. Solution: E – J – R – X.

Type 7, e. g.: "What three movements did the duck and the hare make to get from A to O?" Rule: 1) the duck and the hare move in turn; 2) the duck walks only straight; 3) the hare jumps straight and obliquely, e. g.: duck: X – Y, hare: Y – M, duck: M – R, hare: R – J. Solution: A – B – N – O.

Type 8, e. g.: "What three movements did the duck and the hare make to get from C to K?" Rule: 1) the duck and the hare move in turn; 2) the duck walks only obliquely; 3) the hare only jumps straight, e. g.: duck: D – J, hare: J – T, duck: T – W, hare: W – U. Solution: C – I – G – K.

The Development 1 program consisted of three parts. In the first part (about 15 minutes), a teacher, together with children, analyses the solution to a typical problem. This is necessary so that children understand what needs to be found in problems of this type and how it can be done. Children are given tools for parsing tasks and ways to manage the search for a solution and control their actions. In the second part (about 30 minutes), children decide on their own 12-15 tasks, applying the knowledge gained in the first part. In the third part (about 15 minutes), a teacher and children check the solved problems and analyse the wrong decisions, again showing the techniques for analysing problems and ways of managing mental activity.

Before and after 28 lessons of the Development 1 program, a special lesson was held where children in a group form solved problems in which they had to replace letters with single-digit numbers, e. g.: NG + GN = MM can be replaced as follows: 24 + 42 = 66. Solution tasks of this type are associated with the use of different kinds of thinking skills: the ability to reason, compare and plan.

First, the teacher, together with the children, analysed the problem: T H + P = T T and explained the requirements: 1) different letters are replaced by different numbers, the same letters – by the same numbers; 2) after replacement, a correct arithmetic example should be obtained.

Then a form was given with two training problems and three main problems, where it was necessary to solve arithmetic examples with three-digit numbers:

Training tasks:

VK + M = BB
DZ - N = DD
The main tasks:
1. PMH 2. BVG 3. SPP
+ HMP - DBV + PZZ
MKM YDD FSS

The solution of the training problems in the lesson was checked (together with the children), the solution of the main ones was not checked.

Table 1. The formation of thinking skills in the control (C) and experimental (E) groups in September and May

Period	September	May
Group C	48 (40.7%)	61 (51.7%)**
Group E	47 (38.5%)	84 (68.9%)**

Note: ** p <0.01.

According to Table 1, the level of development of mental actions by May increased in both groups: in the control group – by 11.0%, in the experimental one – by 30.4%. In September, the difference between both groups is minimal – 2.2%, in May it is statistically significant: 17.2% (p <0.01).

Pupils of the control (C) and experimental (E) groups (in relation to all students of the control and experimental groups), who did not solve a single problem with three-digit numbers (Subgroup A), solved one problem (Subgroup B) and solved two problems (Subgroup C) in September and May.

Table 2. Children who solved a different number of problems when assessing the formation of mental skills

Period	September			May		
Subgroups	A	B	C	A	B	C
Group C	8 (6.7%)	25 (21.2%)	37 (31.4%)	3 (2.5%)	18 (15.3%)	36 (30.5%)
Group E	11 (9.0%)	29 (23.8%)	34 (28.7%)	0 (0.0%)	6 (4.9%)	32 (26.2%)

According to Table 2, the total number of subgroups by May decreased in the experimental group more than in the control, respectively: by 20.4% (Subgroup A – by 9.0%, B – by 18,9%, C – by 2.5%) and by 11.0% (Subgroup A – by 4.2%, B – by 5.9%, C – by 0.9%). This fact explains why the increase in the number of children who solved three problems in May is greater in the experimental group than in the control group.

In general, the conducted research has confirmed the initial hypothesis that classes under the "Development 1" program significantly contribute to the development of mental actions associated with solving search problems. The table shows that the results of the experimental group are statistically significantly different from the results of the control group.

At the same time, the results obtained have certain limitations: a relatively small sample size (118 schoolchildren in the control group and 122 schoolchildren in the experimental group), features of the problematic material of the Development 1 program: a) entertaining, non-educational content of the proposed tasks; b) the search nature of the tasks; c) a variety of types of problems (8 types of plot-logic problems, 5 types of comparative problems, 7 types of spatial problems and 8 types of routing problems).

Important conditions for the successful implementation of the program are the features of

developmental classes: their total number, frequency, duration, regularity, as well as the structure of each lesson. Thus, 28 sessions were held for nine months (from September to May) once a week. Each lesson lasted 60 minutes and consisted of three parts: preliminary discussion of actions to solve problems (about 15 minutes), independent problem solving (about 30 minutes), final discussion (about 15 minutes).

The study provided new information about the conditions the development of mental actions associated with solving search problems in 9.5-10-year-old schoolchildren who are studying in the 4th grade. The data obtained expand and clarify the ideas of developmental psychology about the possibilities of intellectual development of children of primary school age, in particular, primary school graduates.

It should be noted, concluding the discussion of the characteristics of the study, that the program "Development 1" tested in the study is one of the possible ways of intellectual enrichment of the learning environment, realised by including extracurricular activities in the educational program of the primary school.

Conclusion

The aim of the study was to determine the conditions for the development of mental actions associated with solving search problems in 9.5-10-year-old children, studying in the 4th grade of the primary school. As a result of the experiments, it was found that the author's program "Development 1" (28 types of tasks of non-educational content) really acts as an essential condition for achieving this goal.

New knowledge about the conditions of development obtained in the study of mental actions associated with solving search problems, expands and clarifies the ideas of developmental psychology about the possibilities of intellectual development of younger schoolchildren.

The established effectiveness of the Development 1 program suggests that developmental programs based on non-educational material can become a basis for the intellectual enrichment of the educational environment of primary schools.

According to teachers, the Development 1 classes led to positive changes both in the activities and in the behaviour of students. So, teachers began to use more search, non-standard problems in their work, while schoolchildren became more active in the classroom when discussing difficulties that arise when solving mathematical problems, and when choosing examples illustrating the learned rules of grammar.

At the next stages of our work on determining the conditions for the development of mental actions associated with solving search problems, it is planned to conduct a similar study with schoolchildren in grades 3 and 2. This will make it possible to more fully and more accurately assess the influence of the discussed program on the development of mental actions.

Based on the materials that can be obtained from these data studies, it is planned to develop a comprehensive program for teaching the thinking of primary school children, where the Development 1 program will serve as a propaedeutic for the development of critical and creative thinking.

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Развитие мыслительных действий у детей 9,5-10 лет

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Аннотация

Ускорение научно-технического прогресса требует повышения уровня профессиональной квалификации специалистов, что приводит к усложнению образовательных программ на всех уровнях образования, включая начальную школу. Овладение учащимися более сложными, чем раньше, знаниями, умениями и навыками деятельности предполагает более высокий уровень развития навыков мышления. Недостаточное развитие этих умений затрудняет овладение детьми понятиями, разработанными в современной науке. Обеспечение более интенсивного развития мышления в начальной школе осуществляется с помощью изменения форм обучения или оптимизации его содержания. Первый подход можно условно квалифицировать как психологический, поскольку он не связан с изменением содержания информации, которая передается учащимся, а направлен на изменение условий ее передачи. Второй подход можно считать педагогическим, так как он связан с изменением содержания передаваемой информации. Можно предположить, что исследования, связанные с разработкой методов обучения мышлению, относятся к первому подходу. Целью исследования явилось определение условий развития мыслительных действий у детей 9,5-10 лет. Гипотеза исследования состояла в том, что в качестве такого условия выступает авторская программа «Развитие 1», включающая в себя 28 видов нестандартных заданий внеучебного содержания. Контрольную группу составили 118 детей, экспериментальную – 122. Дети экспериментальной группы

участвовали в 28 групповых занятиях (с сентября по май, по одному занятию в неделю). Проведенные исследования показали, что занятия по программе «Развитие 1» способствуют развитию мыслительных действий у детей 9,5-10 лет.

Для цитирования в научных исследованиях

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Ключевые слова

Дети 9,5-10 лет, развитие, умственные действия, развитие мыслительных действий, развивающая программа.

Библиография

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