METASUBJECT COGNITIVE COMPETENCIES CHILDREN 10-11 YEARS OLD

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Abstract. *The article presents a study aimed at studying the influence of different educational environments in primary schools - traditional ones of a different nature and built according to the system of D.B. Elkonin and V.V. Davydov. – to develop meta-subject cognitive competencies in children in grades 4 and 5. In two series of group experiments, children solved plot-logical problems of the author's "Deduction" technique. As a result of the study, it was shown that teaching children aged 10-11 years in an educational environment built according to the system of D.B. Elkonin and V.V. Davydov, to a greater extent than their education in a traditional educational environment, contributes to the formation of meta-subject cognitive competencies.*

Keywords: *children 10 and 11 years old, the "Inference" technique, plot-logical tasks, group experiments, meta-subject cognitive competencies.*

1. Introduction.

According to the provisions of the Federal State Educational Standard for Basic General Education [10], children's mastery of primary school educational programs should lead not only to the achievement of subject-specific educational results reflecting the mastery of the curricula of specific subjects, but also to the formation of cognitive competencies associated with students' mastery of the ability to develop ways to solve problems , perform cognitive reflexive actions, plan actions to solve problems, carry out logical actions of constructing reasoning, as well as sign-symbolic actions.

Our understanding of the characteristics of meta-subject cognitive competencies formed in schoolchildren was based on provisions about two types of cognitive activity developed in dialectical logic [7] and implemented in the works of V.V. Davydov [2, 3] and works carried out under his leadership [1, 4, 8].

1.1. Characteristics of types of cognition.

According to the provisions of dialectical logic, a person cognizing the surrounding reality can be aimed at reflecting the internal connections of the objects in question, thus realizing theoretical, meaningful, rational knowledge, and at reflecting their external connections, thereby realizing empirical, formal, rational cognition.

The first case is characterized by sufficient efficiency of cognitive activity, because its result is associated with the identification of the reasons underlying changes in the cognizable object, which serves as the basis for the development of a corresponding pattern.

The second case is characterized by insufficient efficiency of cognitive activity, because its result is associated only with the description and classification of externally presented characteristics of changes in objects of cognition. Within the framework of such cognitive activity, it is impossible to reveal the regular changes in the cognizable object and reliably characterize the features of its existence, both in the past and in the future.

1.2. Methods for solving problems.

Based on the noted ideas of dialectical logic about the types of knowledge, S.L. Rubinstein [9] formulated provisions characterizing two ways of solving problems: theoretical (substantively generalizing) and empirical (formally generalizing). Subsequently, this approach was worked out in detail and specified in his studies by V.V. Davydov [2, 3].

Within the framework of the noted approach, it is argued that with a formally generalizing method of solving problems, the essential and non-essential data relations contained in their conditions do not differ. At the same time, the process of solving problems consists of alternating trials and errors; there is no general plan for achieving results. In this case, the solution method is either not realized, or only the composition of the operations performed is taken into account. This is an empirical way of acting to solve problems.

This method of action is familiar to students from the preschool period of childhood. With this method, in solving a problem there is no separate cognitive (theoretical) part, carried out at the first stage of the solution, and the solution of the problem consists primarily (as already noted) of practical actions of a specific nature.

A meaningfully generalizing method of solving problems is characterized by the fact that in their conditions, essential relationships are highlighted. With this method, a general program of search actions is developed, and therefore there is no trial and error. Along with specific operations, a person in this case also comprehends the connection between the method of solution and essential relationships. The considered solution method qualifies as theoretical.

This method differs from the empirical method in that when implementing this method, solving a problem includes a separate theoretical part, where the problem is studied through cognitive actions (analysis of conditions, a person's understanding of his actions and programming the course of the solution), and a practical part, where, on the basis of specific actions, it is achieved the desired result.

A meaningful approach to problem solving is first systematically mastered through teaching in the primary grades, since when mastering academic subjects it is proposed to solve typical problems in mathematics and grammar lessons.

In general, therefore, the development of methods for solving problems either involves the identification of essential relationships, or the disclosure of essential relationships objectively contained in the conditions of the problems being solved is not expected. In the first case, the development of a solution method is implemented as a meaningful action, the result of which is a general method of solving problems, and in the second case, the development of a solution method is implemented as a formal action, the result of which is a particular method of solving problems.

1.3. Cognitive reflection.

According to the provisions contained in the works of V.V. Davydov [2, 3], cognitive reflection is a person's understanding of the method of his own actions when solving a problem. Depending on the purpose of the noted comprehension (why it is carried out, what is required to be learned), it is necessary, based on the above provisions about the two types of cognitive activity, to distinguish types of comprehension of a method of action, or types of reflexive actions, which represent a person's appeal to his actions when solving a problem.

In the case when the comprehension of the implemented method of action is carried out in order to establish the specific composition of the operations necessary to obtain the desired result, then in one's own actions only their observable features are taken into account.

The considered comprehension of a method of action is associated with the awareness of its characteristics, presented in direct observation, and is qualified as the implementation of external or formal reflexive actions, since it takes into account the connection of the implemented method of action only with the random conditions in which it is performed.

With this understanding of the method of action, tasks with similar conditions are often assessed as the same, and when the conditions are observed to be different, they are assessed as different.

In the case when the comprehension of the implemented method of action is carried out in order to establish not only the specific composition of operations, but, most importantly, the reasons for performing the action in one way or another, then the person comprehends the methods of his own actions in full. When solving a problem, a person has in mind not only the external features of the method of action, but also not directly observable features that are associated with essential relationships contained in the conditions of this task.

Thus, a person's turning to actions in order to find out the reasons and understand the grounds for their successful implementation in the course of solving various problems indicates that consideration of the method of one's own actions is based on its essential and necessary characteristics. This allows a person to meaningfully understand the actions being performed.

The level of awareness under consideration characterizes the implementation of internal or meaningful reflexive actions associated with understanding the connection of the method being performed with significant relationships. When implementing such reflective actions, opportunities are created for a meaningful grouping of internally related problems and placement of tasks that have different solution principles in different groups.

The experimental situation [6], which we developed to determine the nature of cognitive reflection, is based on the noted ideas about the types of cognitive reflection and consists of two stages.

At the first stage, the subject is required to find a solution to three problems: two of them are solved in a general way and differ in the visual characteristics of the conditions, and one problem is solved in a different way and has an externally observable similarity of its conditions with one of the two noted problems.

At the second stage, if these three problems are solved correctly, it is proposed to agree with one, out of five given, opinions about the solved problems. These opinions contain statements about the differences and similarities of the problems solved.

The choice of opinion gives grounds to characterize the type of cognitive reflexive actions performed in the course of solving problems. If an opinion was chosen that indicated an observable similarity in the conditions of the problems, then this meant that formal reflexive actions were carried out in the course of solving problems. When an opinion was chosen that reflected the internal relatedness of the problems, it was accepted that meaningful reflective actions were carried out in the course of solving problems.

1.4. Planning for problem solving.

When analyzing the features of planning, we considered, based on the provisions on two types of cognitive activity, different approaches in the development of a program of action in a problem-solving situation.

Within one approach, solving search problems includes two stages: research and execution. At the first stage, the conditions of the proposed problem are analyzed, associated with the isolation of the data proposed in its conditions and their connections, and the development of an action program to solve the problem. The content of planning at this stage is the development in its entirety of a program for the implementation of previous and subsequent actions to solve the problem. It is important to emphasize that all required actions in this case are outlined before the implementation of the solution to the proposed problem begins.

Within the framework of another approach, the research stage - associated with studying the problem and planning all actions to solve it - is absent. In this case, the plan is drawn up in parts, each of which may include one or more necessary actions. In this case, the next actions are planned only after the previous ones have been completed.

Planning implemented on the basis of the first approach is carried out as a meaningful action, since the program of steps required to solve the problem is developed based on the analysis of all actions required to obtain the desired result.

Planning implemented on the basis of the second approach is carried out as a formal action, since the program of steps required to solve the problem is developed and implemented in parts, separate links, without understanding the content of previous and subsequent actions and their connections within the framework of the entire set of actions necessary to solve the proposed problem.

Based on the presented ideas, we have developed an experimental situation that allows us to determine the type of planning.

First, the subject is asked to learn how to perform some simple action. Then you need to solve a number of problems where it was necessary to apply one or another sequence of such actions.

We found [5] that the selection of problems for such an experimental situation must meet a number of requirements. According to the first of them, it is necessary that the number of actions necessary to obtain the required result increases from the initial problems of the series to the final ones.

In accordance with the second requirement, it is necessary that the sequence of problems proposed for solution includes two problems with an equal number of required actions.

The implementation of the third requirement is that problems should be selected in such a way that they cannot be solved in a general way. The last requirement must be taken into account so that for each problem the required sequence of actions must be redeveloped.

1.5. Constructing reasoning.

When developing criteria and indicators for the development of skills in constructing logical reasoning and inference, the fact that in one case, drawing a conclusion is based on taking into account and correlating all the judgments proposed in the condition and question of the task, and in another case, drawing a conclusion is based on taking into account and correlation among themselves only part of the judgments proposed in the condition and question of the task.

In the first case, opportunities are created for isolating the true relations of the proposed judgments; in the second case, drawing a conclusion from the proposed judgments is possible on the basis of isolating their false relations.

Isolating the true relations of the proposed judgments creates favorable conditions for demonstrating a consistently realized inference, and highlighting the false relations of judgments creates conditions for the emergence of contradictions in the implementation of the inference. In the first case, the construction of reasoning is realized as a meaningful action, in the second case – as a formal one.

1.6. Sign-symbolic actions.

When determining the characteristics of sign-symbolic actions, it was accepted that in some cases, using sign-symbolic means, a person acts meaningfully, since he considers part of the task data (for example, artificial words) as a conditional reality within the framework of a symbolic, representative function, focusing on the relationship "signifier – signified."

In other cases, when operating with sign-symbolic means, a person acts formally, since he does not consider part of the data as a conditional reality and, therefore, treats this data outside the context of substitution or representation.

1.7. Purpose and hypothesis of the study.

The purpose of the study discussed in this section was to determine the characteristics of the development of the indicated higher than meta-subject cognitive competencies.

The study was based on the assumption that teaching children aged 10-11 years in an educational environment built according to the system of D.B. Elkonin and V.V. Davydov, to a greater extent than their education in a traditional educational environment, contributes to the formation of the cognitive competencies in question.

2. Materials and methods.

To achieve the goal of the study, two series of group experiments were carried out using the material of the author's "Deduction" technique [6].

The first series was conducted at the end of the school year with 103 fourth-grade students (traditional educational program), the second series was conducted at the beginning of the school year with 69 fifth-graders studying in the primary grades according to the educational program built on the D.B. Elkonin and V.V. Davydov.

This technique included 20 problems of varying complexity related to plot inferences. Each student received a form with 20 problems and answers to them. It was necessary to choose one of the proposed answers, marking the letter indicating it.

FORM

1. Seva is slower than Viti. Vitya is slower than Nina. Who is the slowest?

a) Vitya; b) Nina; c) unknown who; d) Seva.

2. Katya is more fun than Roma. Roma is more fun than Grisha. Who is the weakest?

a) Roma; b) unknown; c) Grisha; d) Katya.

3. Zhanna has longer hair than Sveta. Zhanna has shorter hair than Lisa. Who has the longest hair?

a) Sveta; b) Lisa; c) unrecognizable; d) Zhanna.

4. Vasya is shorter than Fedya. Vasya is taller than Tanya. Who is the tallest?

a) Tanya; b) Fedya; c) Vasya; d) cannot be recognized.

5. Krtv jumps further than Vstk. Krtv jumps closer than Ngvm. Who jumps the closest?

a) Krtv; b) Vstk; c) cannot be recognized; d) Ngvm.

6. Spkv runs slower than Pftm. Spkv runs faster than Shdgv. Who runs the slowest?

a) Spkv; b) cannot be recognized; c) Shdgv; d) Pftm.

7. Sveta is less than Marina. Marina is better than Dasha. Which of the girls is the most?

a) unknown; b) Dasha; c) Sveta; d) Marina.

8. Olga is better than Yana. Yana is better than Glasha. Who is the boss of everyone?

a) Yana; b) cannot be understood; c) Olga; d) Glasha.

9. Nmkr eaee than Knvt. Knvt eaee than Vdshs. Who is the most?

a) cannot be found out; b) Vdshs; c) Knvt; d) Nmkr.

10. Prfsh stvk than Sdvt. Sdvt stvk than Bchnp. Who's calling everyone?

a) Bchnp; b) Sdvt; c) cannot be solved; d) Prfsh.

11. A squirrel is smaller than a butterfly. The squirrel is bigger than the bear. Who is the least?

a) unknown; b) butterfly; c) bear; d) squirrel.

12. A cow is lighter than a cat. A cow is heavier than an elephant. Who is the heaviest?

a) cat; b) unknown; c) elephant; d) cow.

13. Volov is 69 years younger than Zhukov and 7 years older than Lozov. Who younger than everyone else?

a) Lozov; b) Volkov; c) unknown who; d) Zhukov.

14. Bukin is 3 cm shorter than Gurov. Bukin is 74 cm taller than Kamov. Who is the tallest?

a) unknown; b) Gurov; c) Kamov; d) Bukin.

15. Vitya walked slower than Bori. Gena walked faster than Vitya. Who walked the fastest?

a) Borya; b) Vitya; c) Gena; d) unknown.

16. Igor is more active than Vitya. Gena is more passive than Igor. Who is the most passive?

a) Vitya; b) unknown; c) Igor; d) Gena.

17. Galya solves problems better than Dasha and learns poetry faster than Sveta. Galya solves problems worse than Sveta and learns poetry slower than Dasha.

Who solves problems the worst?

a) Dasha; b) unknown; c) Galya; d) Sveta.

Who learns poetry the slowest?

a) Dasha; b) unknown; c) Galya; d) Sveta.

18. Nikita is braver than Kolya and younger than Gena. Nikita is more cowardly than Gena and older than Kolya.

Who is the bravest?

a) Nikita; b) Kolya; c) Gena; d) cannot be recognized.

Who is the youngest?

a) Nikita; b) Kolya; c) Gena; d) cannot be recognized.

19. Ira knows more words than Nina. Nina dances better than Lara. Lara jumps higher than Ira. Ira dances worse than Lara. Lara knows fewer words than Nina. Nina jumps lower than Ira.

Who knows more words out of everyone?

a) Ira; b) unknown; c) Nina; d) Lara.

Who dances the best?

a) Ira; b) unknown; c) Nina; d) Lara.

Who jumps the highest?

a) Ira; b) unknown; c) Nina; d) Lara.

20. Petya is more talkative than Roma. Roma dives better than Seva. Seva sleeps less than Fedya. Fedya dives worse than Seva. Seva is more silent than Roma. Roma sleeps more than Fedya.

Who's the most talkative?

a) Roma; b) Fedya; c) unknown; d) Seva.

Who is the worst diver?

a) Roma; b) Fedya; c) unknown; d) Seva.

Who sleeps the most?

a) Roma; b) Fedya; c) unknown; d) Seva.

* * *

In this methodology, problems 1-4 are associated with determining the formation of logical actions of constructing reasoning (based on asymmetric relational judgments).

The correct solution of all problems allows us to assume that the construction of reasoning was based on the implementation, when correlating judgments, of actions of a substantive nature.

Problems 5-10 are related to determining the formation of sign-symbolic actions. The correct solution of all problems allows us to assume that in this case the student meaningfully operated with sign-symbolic means, taking into account the nature of the data contained in these problems.

Problems 11-14 are related to determining the formation of actions to develop a general method of solving problems. The correct solution of all problems indicates the completion of a meaningful analysis of the proposed conditions, on the basis of which the student acted in a general way when solving problems.

Problems 15-16 are related to determining the formation of cognitive reflexive actions. When, as an answer to problem 15, a student indicates that Kolya and Vova walked faster, and as an answer to problem 16, he indicates that Vitya and Dima were easier, then these facts indicate that the student has carried out meaningful reflective actions. In this case, the student's answers are based on the completeness of his orientation in the actions being performed, which is associated with the correlation of both judgments during the consideration of the proposed conditions.

Problems 17-20 are related to determining the formation of planning actions based on the ability to act in the mental plane. It is important to note that solving these problems involves operating "in the mind" with a large number of judgments (relative to previous problems), which requires the construction of more complex reasoning.

The correct solution to all the problems under consideration allows us to assume that in this case the student's planning included a research stage associated with the development of a program of required actions, and was implemented as a meaningful action.

3. Results.

As noted, in the first series of group experiments using the method under consideration, 103 4th grade students studied in a traditional educational environment (contingent 1) participated in the first series; 69 5th grade students (contingent 2) participated in the second series. The results of processing the obtained results are presented in the table.

Table. The number of students of both contingents who solved problems 1-4, 5-10, 11-14, 15-16, 17-20 (in %)

Tasks / Contingents	1-4	5-10	11-14	15-16	17-20
1	55,3	51,5*	53,4**	14,6	20,3
2	66,7	65,2*	71,1**	23,2	30,4

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

The data presented in the table indicate differences in the level of development of cognitive competencies among schoolchildren who studied in different educational environments: traditional (contingent 1) and built according to the system of D.B. Elkonin and V.V. Davydov (contingent 2).

Thus, the greatest differences in the development of cognitive competencies between both contingents are in relation to competencies related to the development of a method for solving problems and the implementation of sign-symbolic actions.

In the first case, in contingent 1, 53,4% of students coped with problems 11-14 (related to the development of a method for solving problems), and in contingent 2 – 71,1% (the differences in the noted indicators are statistically significant, – with p < 0. 01), in the second case, tasks 5-10 (related to the implementation of sign-symbolic actions) were successfully solved, respectively: 51,5% and 65,2% (the differences in the noted indicators are statistically significant, at $p < 0.05$).

In addition, there are significant (but statistically insignificant – at $p < 0.05$) differences between the considered student populations in relation to the level of development of cognitive competencies associated, firstly, with cognitive reflection, and secondly, with planning problem solving, thirdly, with the construction of reasoning.

In the first case, in contingent 1, when solving problems 15 and 16, 14,6% of students carried out meaningful cognitive reflection, and in contingent 2 – 23,2%, in the second case, the solution of problems 17-20 was meaningfully planned, respectively: 20,3% and 30,4%, in the third case, when solving problems 1-4, meaningful actions to build reasoning were performed, respectively: 55,3% and 66,7%.

4. Conclusion.

In this study, group experiments were conducted with fourth-graders who studied in a traditional educational program, and fifth-graders who studied in primary grades in an educational program built on the system of D.B. Elkonin and V.V. Davydov. All subjects solved the problems of the author's "Deduction" method.

The results of the experiments confirmed the initial hypothesis of the study, related to the fact that the education of children aged 10-11 years in an educational environment built according to the system of D.B. Elkonin and V.V. Davydov, to a greater extent than their education in a traditional educational environment, contributes to formation of meta-subject cognitive competencies necessary for effective learning in secondary school.

This fact can be explained by the fact that in the course of studying in an educational environment built according to the system of D.B. Elkonin and V.V. Davydov, children purposefully form educational activities, including the formulation of an educational task and educational actions related to its solution.

The meaning of setting an educational task for schoolchildren is to form meaningful actions in them, aimed, in particular, at developing a general method for solving problems of a certain class based on identifying the relationship that is essential for their construction and at carrying out sign-symbolic actions to model the selected relationship.

In addition, in the course of solving a learning task, meaningful actions are formed that are also related to planning, since a full-fledged solution to a learning task involves the development of a series of problems solved in a general way, and the implementation of cognitive reflexive actions related to the student's control over the correct execution of his learning actions.

At the same time, the need for students, in the course of solving an educational task, to justify the sequences of problems they propose, which are solved based on the previously identified essential relationship, and to justify the assessment of the correctness of the educational actions they perform, create good opportunities for students to develop a meaningful approach to constructing reasoning.

In contrast to the indicated characteristics of the learning of junior schoolchildren in an educational environment built according to the system of D.B. Elkonin and V.V. Davydov, when learning in a traditional educational environment, educational activities that involve setting an educational task are not organized, and educational activities that ensure the solution of educational tasks are not formed.

The data obtained in this study, characterizing the formation of meta-subject cognitive competencies in children aged 10-11 years, expands and clarifies the ideas of developmental and educational psychology about the nature of the intellectual development of children of this age, manifested in the development of cognitive and regulatory universal educational actions.

In the future, it is planned to carry out a similar study with third-grade students to determine the degree of development of meta-subject cognitive competencies in children aged 9-10 years.

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МЕТАПРЕДМЕТНЫЕ ПОЗНАВАТЕЛЬНЫЕ КОМПЕТЕНЦИИ У ДЕТЕЙ 10-11 ЛЕТ

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Аннотация. *В статье представлено исследование, направленное на изучение влияния разных образовательных сред начальной школы – традиционного разного характера и построенной по системе Д.Б. Эльконина и В.В. Давыдова. – на формирование у детей 4 и 5 классов метапредметных познавательных компетенций. В двух сериях групповых экспериментов дети решали сюжетно-логические задачи авторской методики «Выведение». В результате исследования было показано, что обучение детей 10-11 лет в образовательной среде, построенной по системе Д.Б. Эльконина и В.В. Давыдова, в большей степени, чем их обучение в традиционной образовательной среде, способствует формированию метапредметных познавательных компетенций.*

Ключевые слова: *дети 10 и 11 лет, методика «Выведение», сюжетно-логические задачи, групповые эксперименты, метапредметные познавательные компетенции.*