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RESEARCH AND EXPLORATORY ACTIVITIES FOR THE INTELLECTUAL DEVELOPMENT OF PRIMARY SCHOOL STUDENTS

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Abstract

The article describes results of the study of the construction of the educational process within the framework of the research and exploratory activities of younger schoolchildren, discusses modern approaches and the importance of such activities for training and development of students. The article provides for the rationale of didactic support of the process of the research and exploratory activities in primary school, covering methods of organization of group and pair work in the lesson, the system of tasks, which contribute to the development of logical thinking, discourse and reasoning, methods of control and self-control, evaluation and self-evaluation. It includes analysis of difficulties students faced while working on training tasks in mathematics and science classes and discusses ways to eliminate those difficulties. The article concludes that the research and exploratory actions of the junior student result in the readiness and ability first to apply knowledge to a new situation in the lesson under the guidance of the teacher, and then do it independently out of hours. The student begins to use knowledge and skills of different educational courses to describe a variety of problems. It helps the student to see the essence of the problem, to find ways of solving it, as mastered during the educational process.

Keywords: Junior student, research and explorative activity.

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1. Introduction

In accordance with the requirements of the Federal State Educational Standard of Primary General Education, each general education organization must create conditions to ensure a high level of education, social training and development of the student (Federal'nyj gosudarstvennyj obrazovatel'nyj standart nachal'nogo obshhego obrazovanija, 2009). Changes that have been made to the content of the education of the junior school student are aimed not only at improving the quality of subject knowledge and skills, but also at the development of meta-subject learning results: intellectual, communicative, regulatory universal actions and adaptability in changing conditions of learning and life. However, the traditional system of education in primary school continues to follow the reproductive orientation of educational and cognitive activities, that has a negative impact on the achievement of modern primary education goals. This trend of the traditional school encourages professionals to pay special attention to technologies built on the research and exploratory activities. Priority of activity, which is based on hypothesis formulation, discussion of the problem, independent application of knowledge in non-standard situations, can ensure successful development of the student's intelligence: logical thinking, discourse and reasoning, ability of children to perform reflexive actions.

2. Problem Statement

The formation of the status of the student as a subject of educational activity is hampered by the contradictions that exist in the Russian education system today between modern requirements on the part of the state, society, the psychological and pedagogical community and the actual situation in education system. This is manifested, first of all, in the reduction of educational motivation in schoolchildren, low level of cognitive interests, lack of autonomy and initiative. Pedagogical diagnostics of younger schoolchildren show that children increasingly choose easy tasks, short texts for reading, struggle to listen to instructions and assignments, do not demonstrate readiness to improve the results of their training, are not ready to look for new or more interesting solutions. It was reported that younger schoolchildren "do not know how to dream: instead of dreams – goals and plans" (Levites, Levites, & Chernik, 2019, p.37), hardly make statements and reasoning, replacing them with a description. One of the reasons for this well-established trend is the prevailing reproductive approach to learning, only occasionally providing opportunities for schoolchildren to research, explore, take initiative and ownership of their learning. If the student does not see, does not realize the value of knowledge acquired by him under the guidance of the teacher or on his own, he is not ready to demonstrate wilful and intellectual efforts to obtain them and embed in system of subject and life perspectives.

The active use by the teacher of one-type tasks, aimed exclusively at working out basic skills in standard situations, still remains a feature of primary school. These tasks clearly present educational or practical situation, obvious data, pre-determined (usually not more than two or three) steps to solve the problem. The inclusion in the lesson of non-standard tasks, which require the student's intellectual efforts at the stage of understanding the task, planning and adjusting their actions, choosing the method of solving, checking the response, analyzing the errors, still remains incidental. This was supported by results of monitoring studies tests performed by graduates of primary school, and by observations during

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experimental work. For example, one of the starting papers on mathematics offered to students of several regions by the Institute for Strategy of Education Development of the Russian Academy of Education at the beginning of the 5th grade included tasks that identified the difficulty of children in applying the same basic skill in a standard and non-standard situation.

2.1. Let us consider examples of tasks and typical mistakes of fifth-graders

Task 1. Forty kilograms of pears were brought to the store. All pears were put equally into two boxes and a quarter of all pears from one box were sold. How many kilos of pears were sold? Students needed to choose and note the correct answer from the suggested answers: 5 kg, 10 kg, 16 kg, 20 kg. About 60% of students solved the task correctly - received the answer “5 kg”. Students who noted incorrect answers could do so for the following possible reasons:

- they are not ready to analyze the proposed practical situation. They considered that the quarter was from the whole quantity rather than from from the half, and chose the answer “10 kg”;

- they could not perform the reasoning. They limited themselves to performing only one action – finding half of all pears – and chose the answer “20 kg”;

- didn't control themselves. Those who gave the answer “16 kg” did not correspond it to the proposed situation: sold a quarter – an insignificant portion – from the half (from twenty kilograms), so 16 kg could not be sold.

Obviously, mistakes could be made for other reasons: not all the conditions of the problem are identified, the student replaced the question of the problem (calculated the remainder instead of the part of the amount), replaced a part of the number with a number, etc. Note that during further individual discussion, the vast majority of students who made a mistake did not find it difficult to answer such questions: “How do you understand the words “half of a number”, “part of a number”? How to calculate a part of the number? Is it possible to check if the part of a number is correctly found?” This suggests that students have sufficient subject knowledge to solve the problem, however, they are not able to apply it.

Let us consider the task of a higher level of difficulty. Complexity in this case is driven by an implicitly represented price-quantity-cost relationship, discovered by the student independently, based on the experience of life or applying mathematical reasoning.

Task 2. “15 fifth-graders and 20 fourth-graders came to the chess museum. All students bought tickets at the same price. For tickets for fourth graders they paid 300 rubles more than for tickets for fifth-graders. What is the ticket price? Write down the answer, make a numeric expression to answer the task question.”

The assignment was offered repeatedly within the framework of the monitoring of achievements of fourth graders (2016, 2017), in the analysis of mathematical level of competence of fifth-graders for basic school education (2017-2020). These studies were organized by the Center for Quality Assessment of the Institute for Strategy of Education Development of the Russian Academy of Education (led by G.S. Kovaleva) with the participation of the staff of the Laboratory of General Primary Education (led by prof. N.F. Vinogradova)

On average, about 40% of students received the correct answer when performing this and identical tasks, and only 20 -25% of them were able to write down a numerical expression that demonstrated their

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reasoning skills in the language of mathematical science. In this case, the numeric expression "300:(20-15)" contains two steps of reasoning. To make it, the student analyzes the data, draws a logical conclusion that 300 rubles were paid for the number of tickets that is the difference between the number of tickets purchased for the fourth grade and the number of tickets purchased for the fifth grade. In case of difficulty, the conclusion could be "seen" using the task model – the skill of the student and his experience should suggest him this auxiliary step. The model can be described as follows: in the upper row of 20 cells – "tickets": in the lower row – 15, the cells of the upper and lower row are placed one under the other; five "extra" cells of the upper row are circled and under them the entry "300 rubles" is made. On the model one can immediately see that 5 tickets cost 300 rubles, which allows to answer the question of the task quickly.

The study revealed that it was easier for schoolchildren to get the correct answer ("60 rubles"), than to explain it using a mathematical record – a numeric expression. It should also be noted that in many cases children who received the answer do not take steps and efforts to explain it, prove it, even if it is required and evaluated separately. This occurs primarily because of the lack of ability of the student to exercise self-control. This ability is underdeveloped due to the lack of clear instructions in textbook assignments, or special explanations by the teacher. For example, as a rule, students take into account conditions of a task, but do not understand whether the explanation should be brief or detailed.

Participation of Russian junior schoolchildren in the international comparative study on evaluation of mathematical and natural science literacy (TIMSS-2011, 2015) demonstrated that fourth graders easily cope with tasks for the application of knowledge in situations which are familiar, worked in the lesson or periodically encountered in everyday life, but it is difficult for them to use basic knowledge when solving new educational or practical problems (Mezhdunarodnoe issledovanie po ocenke kachestva matematicheskogo I estestvennonauchnogo obrazovanija, 2016). The same research notes the lack of readiness of schoolchildren to build and make out reasoning in the process of solving non-standard problems. This is relevant to a group of tasks classified as "reasoning" by the authors of the study on types of cognitive activities (Mullis, Martin, Foy, & Hooper, 2016).

3. Research Questions

So, it should be noted that schoolchildren are not trained to analyse the situation in its development. Most students easily answer questions "What is known?", but cannot answer "How to use that known in this context?"; have difficulties in the construction of reasoning, take limited steps that hardly link into a logical solution; weakly control the course and results of their work. In this case, assistance is required not only to the student, but also to the teacher, in particular, in organizing the didactic process as a research and exploratory activity. The study was carried out to reason and create the didactic support for the training of younger schoolchildren in mathematics and science, that could enable development of their research and exploratory activities using specially designed tasks and non-traditional forms of organization. The study focused on the role of research and exploratory exercises for the intellectual development of students – their logical thinking, discourse and reasoning, methods of control and self-control.

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4. Purpose of the Study

Analysis of modern types of activities used in modern systems of education. Assessment of the types of organization of education prevailing in modern primary school. Organization of pedagogical experiment: justification, development and approbation of the system of tasks reflecting the peculiarities of research and exploratory activities; review of types of organization of training, contributing to learning the search structure, mini-research, collective research by younger schoolchildren. Evaluation of training results, adjustment of content and technology of presentation of research and exploratory activities. Findings of researchers of the laboratory of primary general education were used to characterize research and exploratory activities (Funkcionalnaya gramotnost mladshego shkolnika…, 2018; Universal'nye uchebnye dejstvija kak rezul'tat obuchenija v nachal'noj shkole:…, 2016).

5. Research Methods

The study revealed that the reproductive activity prevails in modern primary school, that provides insufficient contribution to higher intellectual ability of a junior student. This has a negative impact on the success of training in situations where students are offered non-traditional tasks. Younger schoolchildren find themselves helpless when making assumptions, analyzing and summarizing information, monitoring and evaluating their activities. Didactic support of the learning process, built on research and exploratory activities using the system of specially designed tasks and types of organization, has a positive effect on the intellectual development of a junior student.

6. Findings

The importance of using group, pair, individual work is proven in the research of many famous teachers and psychologists (Zuckerman, Kovaleva, & Kuznetsova, 2013). Dyachenko (1991) noted that training as “a communication between those who have knowledge and experience, and those who acquire it” (p. 19) should be carried out in individual, pair, group or collective form. He considered the work of students in changing pairs to be the most effective. Its peculiarity is that each student in a pair takes on the role of a teacher or a student, further children change roles. Research carried out in the Laboratory of General Primary Education of the Institute for Strategy of Education Development has proved to substantiate and test the following model for the organization of research and exploratory work in a pair or in a group (Vinogradova, 2017).

Stages of work in pairs.

- Hypothesis
- Targeted analysis of the problem (working with text or other sources, monitoring) according to the plan, taking into account all conditions of the task.
- Fixing results in a text or a model.
- Giving explanations and proofs.
- Establishing the truth (falsity) of the hypothesis.

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6.1. Features of participation of a junior school student in the research and exploratory activities

Let us present some features of tasks and exercises that will help identify them as research or the research and exploratory:

- the existence of a problem or a problem issue;
- lack of an obvious answer;
- mandatory assessment of one's own knowledge and lack of knowledge;
- possibility of different points of view, methods of solution or design;
- provocation to the discussion (the occasion is a conflict of knowledge, presentation of different opinions);
- construction of a summarized solution, joint making of conclusions compelling for all.

The research and exploratory activity of the junior school student (experiments, discussion of the problem, choice of alternative, etc.) begins with the formulation of the goal of solving the educational problem (Universal'nye uchebnye dejstvija kak rezul'tat obuchenija v nachal'noj shkole:…, 2016). Understanding the goal gives the student the opportunity to carry out the basic research steps:

– analysis of the situation and construction of the assumption regarding the research progress;

– identification of the information needed to achieve the goal and its use to construct reasoning – the course of the decision;

– control and self-control of the progress of work.

As part of front work, it is extremely difficult to organize research and exploratory work of younger schoolchildren, so it is advisable to carry out pair and group work from first grade, enabling the training of children in a more comfortable situation (a small group, the opportunity to speak out, the need for action on an equal footing with all, getting the help of participants of the training team if necessary).

6.2. Examples of tasks for the development of the student's research and exploratory activities

As part of the research work, younger schoolchildren were offered tasks for the development of intellectual skills, discourse and reasoning, methods of self-control. Let us consider the specific exercises for each of these three task groups.

- Exercises on analysis of conditions, making and checking assumptions, solving logical problems.

Assignment 3. (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2014)

Misha has cards like this with numbers

8 4 9 1 5 3

What is the smallest three-digit number he can make up of them? Each card can only be used once. Write down the answer and his explanation.

It is advisable to organize the work on this task in pairs or groups in the third grade. The work can be organized according to the model of the research and exploratory work. Each student can make a guess about the answer. For example, Student A said it was the number 985 and Student B said it was 134. In the next stage of discussion, everyone will try to prove their point based on the analysis of conditions. As a result, children will conclude that the answer has the following properties: a three-digit number, the smallest

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of the three-digit, each digit used 1 time. A model can be made as a workpiece containing spaces for three characters (such as a rectangle divided into three parts) and the words “smallest”, “numbers do not repeat”, or similar. Next, there is a discussion or reasoning on the choice of numbers for each place, starting with the first (with hundreds). During the discussion, Student A will come to the conclusion that his hypothesis had a mistake, since in his number of 9 hundred, any number with another number of hundreds will be less. The hypothesis of Student B is confirmed: the smallest number on the place of hundreds, the smallest of the remaining ones after the record of hundreds and units.

Task 4. Example of verbal logical tasks.

Situation 1. Each is preparing for winter in its own way. Here is the restless squirrel collecting nuts, mushrooms, cashing them in the hollows of trees, into chaps of wood. And squirrel looks at the hedgehog, which by autumn became completely lazy, and will conceive in foliage and nap. - Why are you a hedgehog completely fazed, - asks squirrel. - Why do you not prepare for winter, cashing the food. In winter, there will be nothing. At least you could collect the mushrooms. The hedgehog laughed and quietly answered the squirrel. What did the hedgehog say to the squirrel?

Situation 2. The mole dug his underground passages to the carrot bed and rejoiced: the carrots were ripe and sweet. The hostess pulled a carrot, and saw the mole hanging on it. Is there any errors in the text. Explain.”

As you can see, each verbal logical problem contains a specific problem, the solution of which requires knowledge of the peculiarities of animal life. In the first task, children should notice two contradictions: the hedgehog does not stock food for the winter, because he sleeps in the wintertime, cozily settling in the fallen leaves, and eats nothing. And in response to the proposal of the squirrel to collect mushrooms the hedgehog answered with a smile, as he does not eat vegetable food and mushrooms, he is a predator. The second verbal problem is solved correctly if the students are surprised that the mole has decided to eat a carrot. Children will notice this error in the text: the mole is a predator and will not eat carrots. Answering the task questions, children word a statement with reasoning, which contributes to the development of this difficult type of speech.

- Exercises on building an algorithm, reasoning.

Task 5. (Vinogradova & Kalinova, 2019, p.40) “Finish the statement: Man studies the cosmic space for _____”. The exercise helps to test the ability of third-graders to create judgments, establish causation. During the discussion of the results of the task performed individually or in a pair, the student himself or together with the classmate will be able to substantiate his point of view, to make arguments supporting his thesis.

Assignment 6. (Vinogradova & Kalinova, 2019) “Draw pictographs and explain the properties of water using them. Discuss your work with classmates. Supplement it if you need to” (p.41).

Performing this and similar exercises involves pair or group work of schoolchildren who combine their ideas about the studied subjects (in this case, the properties of water) and present a solution in the requested format. Obviously, during the work the fourth graders will discuss the properties of water, the coding of information using pictograms, as well as how to picture the summarized knowledge. The picture will reflect the development and result of the reasoning made by children, and the logic of the plot will demonstrate the willingness to interpret knowledge with the help of a self-selected topic (e.g., the picture “Seasons”,

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which reflects the properties of water in seasonal natural phenomena). Mistakes will prompt the teacher to carry out the group discussions of the work done and establish the cause of the mistakes.

- Exercises to control the activities.

The self-control ability is a component of learning activities. Attention to its development contributes to the gradual formation of reflexive abilities of a personality. The development of self-control in primary school is assisted by the use of special tasks or additional problem questions that encourage the child to control and correct actions, make corrections, etc. in the course of conducting an educational search or analysis of the results obtained. Self-control in research and exploratory activities assumes that the student asks himself questions: “Is this step needed in the decision?”, “How to rationally execute an action?”, “Is the question answered?”, “What is the cause of the difficulty?” (Funkcionalnaya gramotnost mladshego shkolnika…, 2018).

Let us give an example of an exercise based on the material of a mathematics task, which was successfully done by about 50% of Russian fourth graders in the international comparative study TIMSS in 2011. The task required to specify the correct answer. During the study conducted on the problem presented in this article, different groups of fourth graders of the same class were asked to explain one of the wrong solutions.

> Assignment 7. Petya solved the task: “Sonya has 12 pieces of wire, 40 round beads and 48 flat beads. She uses 1 piece of wire, 10 round beads and 8 flat beads to make 1 bracelet. If Sonia makes the same bracelets, how many bracelets will she be able to make? A) 40, B) 12, C) 5, G) 4.” Petya chose the answer “12". Assume what difficulties Petya could face while working on the task.

Performing such a task in the group will create conditions for discussion of different points of view. The students are required not only to say that the answer “5” can be obtained by dividing 40 by 8, but also to explain what might have led to the mistake (which was made by more than 25% of fourth graders during the international study test). Probably, Petya worked through the task as follows. First he read the text (step 1), then found out what each number means (step 2), then correlated pairs of numbers - the available number of parts (wire, round bead, flat bead) and the quantity of parts per bracelet (step 3). The next step (step 4), should have been to figure out and check the answer. Obviously, Petya made a mistake in step 3 or step 4. In step 3, it was necessary to correlate three pairs of numbers – 1 and 12, 40 and 10, 48 and 8. Selecting the answer “12" is possible if only the first pair of numbers is correlated and the following conclusion is made: “If one piece of wire is required for one bracelet, 12 pieces will be enough for 12 bracelets.” A partial solution in step 3 resulted in the choice of the wrong answer in step 4. If Petya checked himself, asked the question “How many different parts do you need on 12 bracelets?”, he probably would spot the mistake (12 bracelets need 120 round beads and 96 flat ones), corrected it, and chose the correct answer “4”. Similar tasks with comments for teachers are presented in modern mathematics manuals for Russian primary school (Rydze & Krasnyanskaya, 2019).

As part of the study of the topic “What unites different nations?” at the lesson of the world around us for group work, students can be invited to present their perspective on the thesis “universal values that unite religions” (Okruzhayushhij mir: 4 klass…, 2017). While working through the task, the children will discuss ideas presented in different religions. For that, children will apply intellectual universal actions, such as comparison, analysis, generalization, classification. Activities of schoolchildren will include reading and

discussion of textbook texts; discussion of the problem; statement of assumptions; design of a common response scheme. The information received by each participant will be evaluated, adjusted, supplemented and corrected.

The result of search and research actions of the student to solve the educational problem is the ability of the junior student to carry out transfer of knowledge to a new situation (in the lesson, or out of hours). The student begins to use languages of different subjects as means of describing reality, which allows him to see the situation, analyze it in terms of known facts, skills, ways of action in a new way, rather than only in a domestic context.

The above universal actions and examples illustrating them, which are increasingly used in the educational process of primary school, help the student to be an active participant in learning, develop his desire to expand the scope of his activities, to look beyond the boundaries of specific educational situations and known social roles (“I am a first-grader”, “I am a member of the class group”, etc.)

7. Conclusion

Reproductive activities, a priority in primary school today, should be significantly reduced by increasing the proportion of research and exploratory activities.

Research and exploratory activities provide a positive influence on the intellectual development of the junior student - logical thinking, coherent verbal reasoning, development of self-control.

The developed and experimentally tested tasks on mathematics and science, which require assumptions wording, algorithm construction, control of both the progress and performance results, construction of judgments, choice of a proof, etc.) allow to effectively influence not only the subject results of training, but also the level of development of intellectual activity of students. Ideas and the system of tasks presented above can be used by primary school teachers in lessons, by methodologists to illustrate the features of modern methods of primary education, by the school administration in the development of approaches and selection of the content of tests and the knowledge assessment.

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