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Psychological and Pedagogical Foundation of Work with Problem Solving Situations as a Means of Forming Universal Educational Activities among Elementary School Children

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Abstract--- *The Federal State Educational Standard (FSES) of elementary general education states one of the most important goals of elementary education to be the development of the pupil's personality on the basis of acquiring universal educational activities which ensure the mastering of the key competences that make up the core of the ability to learn. The topicality of the study is stipulated by the need to develop and apply individual techniques and methods of the formation of universal educational activities among elementary schoolchildren. Therefore, this article is aimed at identifying the possibility of using various methods of handling problem solving situations in order to develop universal learning activities. The article presents basic methods of working with problem solving situations: mastering the way pupils acquire new knowledge; the technique of predicting; verbalization of the sign-graphic model; the model structuring based on the verbal description, creative interpretation and transformation of the model from one type to another; drawing up a chain of reasoning on the selection of the initial data, filling in the gaps in the task, etc. The article can be valuable for the pedagogical theory and practice since the authors have described the experience of working with problem solving situations as one of the means of forming universal learning activities. The materials of the article can be useful in the educational practice of the elementary school in the process of formation of universal educational activities among elementary school childrena.*

Keywords--- *Universal Educational Activity, Problems Solving Situation.*

I. INTRODUCTION

The national pedagogy as a science has recently been marked as one with a defined trend towards the universalization of the content of education, which assumes personal and cognitive development of elementary schoolchildren and provides them with one of the most important competences of this age period – the ability to learn. At the same time, the main attention is devoted (apart from a simple accumulation of new knowledge) to the skillful use of this knowledge and skills to adapt to a changing environment. It should also be noted that the most important task of the modern educational system is the formation of universal educational activities (UEA), in

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different fields (personal, communicative, cognitive, regulatory) which provide children with the ability to learn, self-develop and self-improve [2]. It is the initial stage of school education that should provide cognitive motivation and interests among children, inspire them to be ready and able to cooperate with a teacher and classmates, form the basis of moral behavior that determines the relationship of the individual with the society and people around through the lesson activity. Since the priority of new educational standards is the application of the developing potential of elementary general education, an urgent task consists ensuring the development of universal educational activities as the actual psychological component of the educational basis, along with the traditional presentation of the subject content of specific disciplines.

The key moment in this process can be identified as a number of meta-subject results, which are formulated as follows:

- The ability to define concepts, create generalizations, establish analogies, classify, independently choose reasons and criteria for classification, establish cause-effect relations, build logical reasoning, infer (inductive, deductive and analogy) and draw conclusions;
- The ability to evaluate the correctness of the given educational task and assess one's own possibilities for solving it;
- The ability to create, apply and transform signs and symbols, models and schemes for solving educational and cognitive tasks [19].

A number of scientific publications of domestic and foreign researchers devoted to the problems of the formation of UEA among elementary schoolchildren during mathematics lessons have appeared recently. A number of researchers [1, 6, 12, 21, 22] focus on the possibility of using training, problem-searching tasks, tasks of algebraic and geometric content in the process of working with problem solving situations. Other scientists [2, 3, 4, 7, 9, 16, 20] suggest working with story problems as the basis of forming a system of universal learning activities. A number of studies [1, 5, 6, 13, 14, 15] consider integration of separate methods.

The authors note [23] that research activity can serve as the basis for the formation of universal educational activities; the research activity in the article is defined as specially organized cognitive creative activity of pupils, characterized by pupils' purposefulness, activity, objectivity, motivation and awareness, as well as discovery teaching [24, 25].

II. MATERIALS AND METHODS

This article deals with some individual techniques that contribute to the formation of universal learning activities among pupils in the process of working with problem solving situations.

Since the importance of problem solving situations for the formation of universal learning activities among elementary schoolchildren has already been stated, it should also be noted that the process of working with these tasks presupposes the fact that a child has already developed such qualities as the ability to perceive a certain described situation from the position of analyzing some numerical characteristics and relations between them. This skill, like no other, is connected with the development of the children's value-semantic orientation. This skill helps

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correlate certain actions and events, highlight the most significant component within the content, determine the possibility of finding the unknown quantity according to the data available.

The importance of using the whole complex of universal educational activities (personal, regulative, cognitive, communicative) when working with problem solving situations indicates the importance and necessity of using this kind of mathematical tasks in the process of teaching mathematics [2]. Problem solving situations can be viewed as one of the means of forming universal educational activities, as they fully meet all the criteria that are designed to form all the qualities of educational activity among elementary schoolchildren.

When considering private skills in order to solve story problems, experts identify a number of consecutive and related actions that a pupil performs. These actions include the following:

- Reading the task and understanding the presented text, understanding the meaning of each word and representing the situation that is set in;
- Identifying the statement of the problem, the definition of the known and unknown;
- Establishing the connection between the statement and the question of the problem, between the data and the required quantity, i.e. expressing the ability to analyze the text of the problem, the result of which is the choice of arithmetic operations in order to solve it;
- Recording the solution to the problem [6].

All of these skills are in one way or another connected with the performance of mental actions, which form the basis of universal educational activities, and, consequently, the entire success or failure of a schoolchild when handling a problem solving situations will depend on the skills development.

It is also worth mentioning the necessity of forming a whole complex of basic skills required for the child, which includes a number of the following skills:

- Listen and understand the texts of various structures;
- Correctly imagine and simulate the situations offered by the teacher;
- Correctly choose the action in accordance with the described situation;
- Compose a mathematical expression in accordance with the selected action, perform simple calculations (at least, counting or enumeration) [4].

By defining the relative sequence of objective steps when working with a problem solving situation, one should take into consideration that each step includes a sufficiently large number of methodical techniques that both qualitatively affect the process of solving a text problem, and serve for the means of universal learning activities formation among elementary schoolchildren. These methods include various options of the problem analysis, the use of modeling techniques, various techniques and methods for solving the problem, as well as options for verifying the correctness of its solution [9].

III. RESULTS

Let us briefly note those features of the formation of universal learning activities that are inherent in each of the individual stages when working with a problem solving situation, and also focus on the use of specific methodical

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techniques in this process.

One of the basic methods of forming the UEA can be identified as mastering a student ability to obtain new knowledge. The key issue is the development of children's ability to work with a mathematics textbook, which becomes the main means of obtaining new mathematical knowledge and expanding a schoolboy's outlook. It is the very connection established by the child in the process of obtaining new knowledge which forms the basis for the independent formation and subsequent development of universal educational activities.

The first key stage of successful pupils' is learning the statement of the problem and its analysis. The ability to purposefully read the text, and distinguish between what is stated and what is required, determine the degree of sufficiency of the given data, depends mostly on the development of regulatory UEA. In order to form and develop them when working with a problem solving situation, one may use the method of prediction: the entire text is divided into semantic parts, and a step-by-step reading of each involves asking a possible question to the part where the statement is formulated [16]. Pupils can be asked to change the main statement of the problem, and conduct an analysis of the newly obtained situation. In fact, this technique helps visually simulate the analytical and synthetic way of handling a problem solving situation, which will positively affect the search for a solution and the formulation of the statement which will further help make up the question to a task as an organic continuation for the result found. It can be noted that this kind of work is one of the ways to check the correctness of the solution of the basic problem, which also stimulates pupils to take a creative initiative in the process of variation in the question formulation. Let us introduce an example how to use this technique when meeting and analyzing a particular situation.

The task: "*When nine chairs were put in one cabinet, and in the other 12, in both offices the chairs were equally divided. How many chairs were there in the first cabinet, if there were 15 in the second one*?"

If you carefully follow the logic of actions, then this task is solved quite simply; however, the data given in the question makes it difficult to solve the problem. One can use the prediction technique in order to handle this situation, which primarily consists in expressing children's opinions on whether more or less chairs there were in the first cabinet in comparison with the second one.

Children's suppositions are written down, then, one should check the relevance of these suppositions to the problem statement. Pupils may be offered to view this tasks as a graphic model, a draft-picture in order to consider the situation. When making a draft, children designate the number of chairs located in one and another room after the performed action with the pieces of the same length. It is desirable that one piece is located directly under another one. The placed chairs are marked on the each piece (with an approximate proportionality) in order to make sure which of the remaining parts is shorter or longer. This activity will be prove the fact, which office originally had a larger number of chairs.

The work carried out in this way on the basis of prediction method allows not only to avoid any mistake in the choice of arithmetic activity, but also allows to consciously approach the search for a solution, and also make sure that the reasoning is correct since there is a model.

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As we noted earlier, the prediction method can also be used to compose a certain chain of problems, where statements fully correspond to the previously proposed one, while the requirement is formulated in a different way. For this purpose, children can be asked to formulate a number of questions that could be posed to a problem similar to this one. It is possible to concretize children's thinking activity, where they are to change the question in such a way that a completely different result can be obtained. In this case, the statement should remain the same. With the use of the prediction method and fairly simple pupils' reasoning, at least two more questions can be asked for the task discussed. The first may look like this: "How many chairs were in both offices originally?", and the second one – "In which room was there initially the largest number of chairs, and how much more were there?"

When working with textual tasks, it is quite effective to use the verbalization of the sign-graphic model [16]. Considering the essence of this technique, it should be noted that it is in the immediate practical activity, which involves aligning the associated statement with reliance on some model of the problem solving situation. This work is best organized and conducted during several successive stages, where each stage is more difficult than the previous one. At the initial stage, when children do not fully have the ability to independently represent the situation reflected in the model, they can be asked to find the appropriate text. To do this, children are given some kind of graphical model of the problem and several different texts with the same numerical data. The educational task assigned will be to select from the proposed versions of the texts the one which fully corresponds to the presented model of the problem solving situation.

A more complicated task could be the model and the texts offered for analysis (in this case, several models and one text can be varied) without any numerical data. This will somewhat complicate the task of establishing a correspondence between the statement of the task and its sign-graphic model. Reading out the tasks aloud by the teacher (or any pupil) can be another complicated version of the task. In this case, the ability to listen attentively to the content, orally analyze the problem statement and mentally relate it to the presented model are formed.

The most difficult stage for schoolchildren is can be to formulate the statement of the problem for the proposed model. Its complexity lies in the fact that it is quite difficult for children to independently create a correct utterance, which can reflect the essence of the action presented in the model. Therefore, some pre-prepared forms of texts, which are most often used to formulate the statements of problems, can be used as some kind of support. It is important to note that such forms should vary and presuppose not only the direct test construction, as well as transformed presentation. At the same time, the choice of the plot of the task (the actual and causal part of the narrative) is the creative part open for children.

Along with using the technique described above, one can recommend a reverse technique, connected with the compilation of the model based on a verbal description [16]. Here, one should pay attention to the fact that the ability to perceive information "by ear" is one of the conditions for successful mathematical terminology mastering which forms a certain image that allows the content specification of the given task.

In this regard, it will be useful to use various forms of texts describing the statement and formulating the requirement for the problem. One can initially notify children about what kind of modeling will be used. As a rule, in most cases this task will be performed in the form of a short notice, which is the most acceptable version for this

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kind of work. In this case, one should not neglect the compilation of models in the form of pieces or use the techniques of schematic modeling.

The work with the problem solving situation is complex, and therefore teaching children to use models as one of the means of forming and developing the UEA can have various aspects. As a continuation of work with pupils on the skills formation one can use supplementary modeling, which can be named *creative interpretation and transformation of the model from one type to another*. Such work helps identify and test pupils' the abilities to use different methods of modeling as well as to understand the principles of constructing different types of models [15].

Let us briefly analyze the use of different types of modeling in the process of working with problem solving situations. The earlier period of handling a problem solving situation and the process of solving it is known for a child in the form of object modeling in the preschool age. This kind of modeling sufficiently develops the notion of the sense of arithmetic action, allows visualizing those changes that occur when performing manipulations with objects or their substitutes. This type of modeling fully corresponds to the age-related capabilities of preschoolers, introduces the course of reasoning in the process of working with the task.

However, this kind of modeling is not acceptable for working with problem solving situations in lessons in elementary school. It is replaced by techniques of sign-graphic modeling, where the information is coded and submitted in a more concise form.

Here is an example: *"There were 18 planes on the airfield. Before noon, four planes left. How many planes were there at the airport, since two planes returned after a short flight?"*

The first step in creating a supplementary model could be a sketch that could show the cause-effect relations described in the problem statement. However, the analysis of the quantitative data, which this task contains, leads the pupils to the idea that the number of designated objects is too large and it will take quite a long time to draw them. At the same time, in a sketch, it will be necessary to fix those operations or actions that the objects perform or what is done with the objects. Therefore, pupils can choose to execute the model in the form of a sketch with the help of pieces [14].

Graphic skills are not developed sufficiently in this age, so a teacher can offer a partially completed drawing, a sketch. It can be a combination of different length pieces with some blanks to place the available data and designate the requirements. Considering and analyzing the given model with the problem statement, children will have to fill in the blanks, with the corresponding data or a question mark. Performing this simple task helps deeper correlate the text with the completed model.

When working with problem solving situations, one should take into account the ways of using inverse problems in the course of the mathematics lesson. This implies a rather large potential for the development of personal, regulative, cognitive and communicative UEA [10]. It is the compilation and solution of inverse problems which has become the key to the successful formation of pupils' ability to establish cause-effect relations, build a logical judgment, evaluate the correctness of the result of the learning task and outline their own possibilities for solving it, apply and transform signs and symbols, models and schemes.

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Considering the work on the compilation and solution of inverse problems in mathematics lessons as a way to form UEA, we distinguish the method of constructing a chain of reasoning for highlighting the initial data in the problem proposed as the main problem and the inverse problem. While analyzing the text of both tasks, pupils can be asked questions of the following kind: "What is the difference between the direct and inverse problem?" or "What values are required in a direct task and which ones are in inverse task?" It is also useful for pupils to demonstrate the process of solving both the first and second tasks.

The very process of drawing up the inverse problem is also of interest to specialists. In this case, it is considered effective to follow the recommendations formulated by academician P.M. Erdniev on the recording of the element-by-element composition of the statements and requirements of the given task in the form of a numerical chain, where the obtained data can also be added [15].

The essence of this method is that pupils initially write down the task data in the notebook in the order which they appear in the text. The last value in the chain is the answer to the main question of the task. When organizing this type of work, pupils can be asked to first create a chain of data which are presented directly or indirectly in the text, and after getting the answer they add the obtained data to the chain. At the same time, for deeper understanding, the answer can be singled out in any way, by enclosing it in a frame, underlining by a double line or by highlighting, which will allow the pupils to represent the whole elemental composition of the problem integrally [1].

Further work on the formulation of the inverse task assumes that changes will be made to the composed chain, namely, the received answer will become one of the data, and any given data will be allocated as the unknown quantity.

This is how the approach can be applied in practice. Pupils are given the text of the task, which will form the basis for the reverse task.

The task. *Transporting the cargo for a group of geologists, the helicopter flew for 6 hours at a speed of 140 km/h. The return trip to the aerodrome took it 4 hours at a speed of 210 km/h. What was the average speed of the helicopter all the way through?*

One can see that the answer to the main question cannot be obtained by solving one arithmetic expression. Therefore, children can offer a step-by-step solution:

1. First determine the distance that the helicopter traveled to the geologist's village and back to the aerodrome $140 \cdot 6 + 210 \cdot 4 = 1680$ (km),
2. Then find the total time that it was on the way

$$6 + 4 = 10 \text{ (h)},$$

3. Calculate the average speed with which the helicopter was flying

$$1680 : 10 = 168 \text{ (km / h) is the average speed of the helicopter.}$$

As can be seen from the preliminary search for the solution, pupils can receive intermediate values (the total

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distance that it flew is 1,680 km, the total flight time is 10 hours) which, in fact, are not statements for this task. An attempt to introduce an intermediate result should be prevented by the teacher, since the numerical values found by the pupils in the text of the direct task are not directly presented, then it is no use designating them in the chain as a result of the calculations.

The inverse tasks for pupils will be to record all available data in the same sequence. The meaning of the task is that when compiling a numerical chain, pupils are asked to write all the given data in one line from the text of the task, and after finding a solution, they are to add a record to them at the end.

6 h 140 km/ h 4 h 210 km/ h 168 km/ h

Taking into account that the last value was obtained as a result of the calculation performed and is the answer to this task, we mark it with a color. The continuation of the work with the numerical chain for the process of drawing up the inverse task means to introduce any data obtained, and the last result of the calculation becomes a part of the problem statement. The modified chain looks somewhat different, for example:

6 h 140 km/ h 4 h 210 km/ h 168 km/h

As can be seen from the example above, children can easily understand the basic meaning that can be used when composing the inverse task. Pupils can deduce that the solution of the direct task becomes one of the data for the inverse task, and some data can be considered as a task requirement. In this case, the task can be formulated in another way, for example: By transporting cargo for a group of geologists, the helicopter flew for 6 hours at a certain speed. The return trip to the aerodrome took it 4 hours at a speed of 210 km / h. What was the speed of the helicopter's flight to the geologist's village, if the average speed along the way was 168 km/h?

Children can also be recommended to transform this chain themselves, considering all possible options for its compilation. Independent work on the compilation of numerical chains for inverse tasks makes it possible for each student to stay active and creative [1].

The process of compiling an inverse task with the use of a numerical chain must also be divided into separate steps. First of all, children's attention is focused on the number that is allocated in the chain. Pupils find themselves in the text of the direct task what this number means, and only then reformulate the requirement of the task in such a way that the process of finding the given number is included.

Another method of working with inverse problems can be to receive a comparison of the texts of both tasks, in which it is required to determine the order of actions used in the course of each solutions [1]. In this case, it becomes obvious to the pupils that the sequence of actions used to solve a direct task can and must differ from the sequence of actions in the inverse task. It is important to note that when transforming the problem, children identify and use mutually inverse relations between the quantities: in a direct task, the distance is found on the basis of speed and time, then in the reverse – the time is found on the basis of distance and speed.

Также на этапе работы с обратными задачами можно использовать прием *заполнения пропусков в тексте задачи* данных, выделенных на основе анализа содержании условия исходной задачи. В этом случае, как правило, учащимся может быть предложена и самостоятельная формулировка основного вопроса задачи.

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Also, at the stage of working with inverse tasks, one can use the method of filling the gaps in the text of the task; the gaps are pointed out with the content analysis of the original task statements. In this case, as a rule, pupils can also be offered an independent formulation of the main question of the problem.

When transporting the cargo for the geological expedition, the helicopter flew for some time at a speed of ... km / h. The return *trip to the aerodrome took it ... h at a speed of ... km / h. What can be the question to the task?*

Unfortunately, the work on compiling and solving reverse tasks in elementary school is not always systematically conducted, which, in our opinion, significantly reduces the importance of the tasks of this type in the process of forming universal educational activities among schoolchildren.

IV. DISCUSSION

Scientific studies in the field of formation of universal educational activities among elementary schoolchildren are presented in the works of Abramova O.M., Solovyova O.A., Asmolov A.G., Buklin E. N, etc. The methods of working with problem solving situations are considered in the studies by Belyshy A.V., Demidova T.E., Istomina N.B., Pichugina S.S., etc. The authors of this article describe various methods of working with problem solving situations for the formation of universal educational activities among younger schoolchildren.

V. CONCLUSION

The following conclusions can be drawn from the data collected.

Firstly, the formation of universal educational activities among younger schoolchildren in solving story tasks has a more complex and more productive nature of the activities of pupils compared with the performance of other mathematical tasks.

Secondly, the basic methods and methods of forming the UEA when working with textual tasks are an integral part of the whole process of solving the problem and presupposes a systematic use of them in the development of mathematical skills among pupils.

Thirdly, the development and use of methods for the formation of universal educational activities when dealing with textual problems is based both on the main theoretical positions and on practical tasks, thanks to which each individual universal educational action acquires a certain semantic value for the student.

VI. RECOMMENDATION

The materials of the article can be useful in the educational practice of the primary school in the formation of universal educational activities among junior schoolchildren in the lessons of mathematics as well as in scientific and pedagogical studies on the problems of the methodology of mathematics.

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