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V. P. Ruchkina, G. P. Kalinina
Ekaterinburg, Russia

FORMATION OF COGNITIVE SKILLS IN JUNIOR SCHOOLCHILDREN

Abstract. The article deals with an urgent pedagogical problem — formation of universal learning actions as a basis for the development of learner autonomy, which is, in its turn, the basis of cognitive activity of junior schoolchildren.

The processual aspect is especially significant for cognitive activity. Independent activity is determined by the pupil's ability to study the subject, object, phenomenon or process on his own. The level of acquisition of cognitive techniques determines the quality of their self-obtained knowledge and skills. The pupils face two sequential tasks in the process of self-learning of any educational material. The first task is to recognize the phenomenon (object). The second one is to describe it, to explain the reason or mode of existence, to formulate a rule, to modify it, etc. The completion of each of the two tasks presupposes the use an appropriate set of cognitive techniques, common and specific for each academic subject.

The techniques of recognition, description, explanation and transformation are common for all academic subjects. The given techniques and operations are universal; they are relevant for each discipline, but possess certain specific features depending on the characteristics of the subject, the level of proficiency of students and their age. The techniques of recognition, description and explanation dominate in the primary school classroom in almost all academic subjects; explanation and transformation prevail in the upper grades.

Keywords: learner autonomy, primary school, junior schoolchildren, cognitive activity, universal learning actions.

About the author: Ruchkina Valentina Pavlovna, Candidate of Pedagogy.
Place of employment: Associate Professor of Department of Theory and Methods of Teaching Natural Sciences, Mathematics and Computer Science during Childhood, Institute of Pedagogy and Psychology of Childhood, Ural State Pedagogical University.
About the author: Kalinina Galina Pavlovna, Candidate of Pedagogy.
Place of employment: Associate Professor of Department of Theory and Methods of Teaching Natural Sciences, Mathematics and Computer Science during Childhood, Institute of Pedagogy and Psychology of Childhood, Ural State Pedagogical University.

The need of formation of cognitive independence of schoolchildren, of their preparedness for the process of self-education as a reflection of a serious contradiction between the growing demands of society and the traditional organization of the education process be-came urgent in the second half of the 20th century.

Pedagogy has tried to solve this contradiction by searching for new content of education. But the new content distinguished by a high theoretical level, generality and depth came into conflict with methods, means and organization of education slowing down its acquisition. That is why the task to find a new approach, a new turn which would eliminate the contradictions the school faces has become vitally important.

The purpose of modern education to form universal learning actions providing schoolchildren with learning skills, chances of self-development and self-improvement and inclusion of creative potential in activity appears to be such a turn nowadays [7]. The accomplishment of this task may be ensured by shifting accent in the methods and techniques of educational activity, especially in primary school, towards acquisition of optimal methods of independent cognition and practical skills of self-education by learners.

Everything said above underlines the vital importance of formation of cognitive formation skills, which is a prerequisite of learner autonomy of schoolchildren. Our research shows that formation of cognitive activity skills facilitating a gradual transition to its independent performance is quite feasible for junior schoolchildren and, what is more, rather important for them as a mechanism of discovery of new knowledge and organization of independent work.

For cognitive activity, as, by the way, for any other kind of activity, its processual aspect is of prime importance. The functioning of independent activity is wholly determined by the child's ability to cognize an object, thing, phenomenon, or process independently. The level of mastery of cognitive techniques ensures the quality of independently acquired knowledge, habits and skills.

The pupils face two sequential tasks in the process of self-learning of any educational material. The first task is to recognize the phenomenon (object) by determining its properties, constituent parts, structure, ties and relationships, algorithms and transformations. The second one is to describe it, to explain the reason or mode of existence, to formulate a rule and, if necessary, to modify it. The completion of each of the two tasks presupposes the use an appropriate set of cognitive techniques, common and specific for each academic subject.

The techniques of *recognition, description*, *explanation* and *transformation* [7] are common for all academic subjects. Each of these techniques includes a complex of strictly specific and interconnected operations which can be mental, object-based and verbal-logical. Drawing on the modern psychopedagogical works by V. V. Davydov [5], A. K. Gromtseva [4], N. F. Talyzina [11] and other authors, we will consider the main cognitive activity techniques in more detail.

The technique of recognition ensures revealing evident significant properties and qualities of phenomena (objects) lying at the surface, and recognition of ties and relationships, rules and algorithms. This task is accomplished through such actions as observation, test transformation, taking to parts (analysis) and uniting (synthesis), comparison (differentiation and collation), analogy and contrast. Recognition may be accompanied by building models and schemes, revealing design principles, and making conclusions on the basis of an object's belonging to a notion or explaining it, etc.

It should be noted that the technique of recognition is primarily based on intellectual activity which is hardly conscious in the process of cognition. If a person who is good at doing some kind of practical work well is asked how he does it, he will tell about it without delay; and he will precisely describe all actions in the right sequence so that they could be numbered and used as items of a plan. If we ask what he did when he solved an intellectual problem, many professionals would not answer the question with equal ease. They would say that "it dawned on them …", or that they "figured it out somehow', etc. In this connection the teacher's task is to make these intellectual actions "visually" perceptible. This purpose may be achieved through commenting aloud upon the performed cognitive actions, through their preliminary formation, making up a plan of activity and actualizing each point when it is necessary to perform the corresponding actions.

Another peculiarity of such skills is the fact that a cognitive problem is not solved through a single action but through a complex of actions. Consequently, when it comes to the formation of such actions it is advisable to teach students to recognize both one single intellectual action and a whole complex of them.

An important feature of an intellectual action facilitating recognition of objects consists in the fact that the character of this action is closely connected with the content of the cognitive task, i.e. directly with the peculiarities of the object under recognition or the field of knowledge to which this object belongs. That is why the effectiveness of using the given intellectual action depends on the level of proficiency in the content of the field in which the intellectual action is performed.

The technique of description is widely used in all sciences, while learning many academic subjects, in practical work and at home. Description is a verbal presentation of a phenomenon (object) of the real world by means of enumerating its characteristic features. The given type of discourse is aimed at reconstruction of the world of objects and establishment of connections between them. The purpose of description consists in creating a whole mental image for the reader or listener and reflecting the typical features of an object. There are special types of description characteristic of a certain field of knowledge: everyday, portrait, landscape, scientific-technological description, etc. In a broad sense, description may be characterized as a certain model of monologic utterance in the form of enumeration of properties, qualities and typical characteristics of objects.

The technique of description takes a significant place and plays an important role in the cognitive activity of schoolchildren. Ability to use this technique makes it possible for a pupil, on the one hand, to rationally and economically perceive, process and present information from various sources, and, on the other hand, to describe different objects and phenomena in an independent and creative manner. The last consideration saves the pupil from the need to learn by heart and keep in memory a large volume of descriptive material.

For example, primary school pupils with a limited amount of initial knowledge can independently describe any natural number: “427 is an odd, three-digit number, in the series of numbers it is between 426 and 428, it has 4 whole hundreds, 42 whole tens and 427 units. There are 4 hundreds in the class of hundreds, 2 tens in the class of tens and 7 units in the class of ones”.

The technique of description performing the function of ordering and orienting the child in the learning material and own knowledge has two variants – concise and detailed description the use of which is determined by the specificity of the academic subject and described phenomena and objects. Concise definitions are mostly used in mathematics and physics, and detailed descriptions are employed in literature, biology and social science. The technique of concise description includes the following operations: finding a common feature in a series of similar objects and making up a short and clear sentence reflecting this feature; finding all sufficient and necessary features and forming sentences reflecting these features; building a definition.

The above mentioned operations of the technique of description demonstrate a close connection of the given technique with that of recognition. These are practically two interconnected techniques of cognitive activity in which description is the final stage of recognition. In real pedagogical practice, word description is very seldom found in mathematics because it needs a good command of mathematical speech. At best, this stage is completed by the teacher.

Detailed descriptions do not differ from concise ones in their verbal-logical operations make-up. Detailed description presupposes enumerating all significant common features and provision of examples; showing the distinctive features supported by examples. The differences are demonstrated by the fact that a detailed description has much more sentences describing common and distinctive features of a phenomenon. In some disciplines a detailed description may come very close to the level of a literary essay or short story.

At the same time, a number of disciplines including mathematics, in order to single out objects under study and their interrelationships most vividly and laconically use conventional signemic (graphical) phenomenon descriptions called models. In this case, relevant features of objects, their composition, course of action or certain peculiarities of phenomena are described with the help of models of different kinds and degree of generalization. Many objects, phenomena and processes can be described using such models as schematic drawing, scheme, drawing or table, diagram or chart. Graphic representation of object description is widely used in mathematics where modeling is considered to be a decisive factor for theoretical thinking formation, and makes up, in its turn, the foundation of productive thinking.

Concise definitions of mathematical objects are widely used in primary school mathematics. For example, a concise word problem task or any model of a problem or calculation technique is a short description of these objects made up with the help of conventional signemic (graphical) language.

Methodological aspects of application of modeling for description of mathematical objects have been studied by many scholars and methods specialists – V. V. Davydov [5], A. V. Beloshistaya [1], etc. Opportunities for teaching junior schoolchildren modeling activity are dealt with in detail in the work by A. V. Beloshistaya [1]. The results of her research have found wide application in the course of primary school mathematics where schematic models of representation and comprehension of mathematical essence of a problem or calculation technique are often used.

Thus, description can be completed in two ways – through a concise or detailed description or a system of conventional signemic (graphical) description. It is necessary to note that the technique of description in mathematics and other sciences could be widely and effectively used if the pupils knew its specificity, order and sequence of unfolding, composition of necessary and sufficient operations and, of course, had experience of its usage.

The technique of explanation takes the central position in any science, especially in mathematics, because one of the main tasks of cognition is to explain the world, its functioning and development, world order, etc. The ability to reason and explain is the most important universal action demonstrating the conscious mode of the process of learning.

The technique of explanation plays an exceptionally important role in the cognitive activity of pupils. With the help of this technique, the pupils can acquire the prepared information in a deeper and more profound way and independently explain the phenomena under study.

Having a good command of the explanation technique and possessing the necessary amount of knowledge schoolchildren can recognize regular connections and relationships and formulate judgments reflecting these connections and relationships on the basis of observations. The technique of explanation introduced through revealing and foundation of regular connections includes strictly determined operations. Provisionally, we can single out the following ones: observation of the phenomenon to be explained, search and discovery of regularly recurring connections and relationships; formation of the sentence reflecting the revealed connections, substantiation of the connections and, if possible, codification of the sentence, determination of the boundaries within which the regularity is functionable.

Primary school children can use this technique only when they know well its composition, given sequence of completion and have experience of using it. The step-by-step process of teaching this technique is shown in the tables (see Tables 1-3).

In accordance with its functions, *the technique of transformation* has specific operations which differ from those of description and explanation. The composition of the operations of the given technique will be the following: observation and test transformations of a phenomenon, finding and actualization of the transformation rules, their substantiation and usage. For example, a meticulous application of calculation technique and unfolding its operations may be done in the following way.

Let us imagine that we are given an expression of the kind 16 + 7. In order to calculate its value it is necessary to choose the calculation algorithm. This algorithm can be found in at least two ways.

The first way of calculation is based on an algorithm actualizing such knowledge of the pupils as decomposition of a number into a sum of convenient addends, usage of the associative law with reference to the sum and the grouping of numbers, and, then, knowledge of the previously learnt calculation techniques. The second approach presupposes the use of a visual schematic model of the calculation technique and knowledge of the class composition of a number.

Making test transformations in the course of work over several similar expressions (26 + 9; 34 + 8; 76 + 5) and observing and generalizing the accomplished test transformations the pupils can formulate the rule: "In order to add a one-digit number to a two-digit number, it is enough to decompose the one-digit number into convenient addends so that one of the addends would complete the first number to the power of ten, then add the first addend to the two-digit number to complete it to the power of ten, and after that add the second addend to the power of ten". This reasoning for primary school children should be carried out on a concrete example supporting it with a schematic model of calculation and complete recording of reasoning with the help of a symbolical model.

The given techniques and operations are universal; they are relevant for each academic discipline, but possess certain specific features depending on the characteristics of the subject, the level of proficiency of students and their age. The techniques of recognition, description and explanation dominate in the primary school classroom in almost all subjects; explanation and transformation prevail in the upper grades. Mathematics uses a conceptual and coding language (language of formulae). Literature and history mostly employ conceptual and imaginative-figurative language. The time spent by the teacher on teaching each technique will be also different because the level of difficulty of technique acquisition is not the same. Thus, the techniques of recognition and description are much easier to master than the technique of explanation.

While teaching pupils the main techniques and operations of cognitive activity, it is necessary to observe certain conditions. We will now describe some of them.

In order to let the pupils independently describe an object or phenomenon and carry out all sequential operations and learn to arrive at certain conclusions by themselves, it is necessary to:

– clearly formulate the task indicating the type of description (concise, detailed, schematically presented or descriptive);

– offer an object for observation in any form (natural, schematic or symbolic model, or in the form of description);

– provide all necessary previously learnt basic notions: object's and its parts' name, terms, symbols, and, possibly, special prearranged schemes reflecting the structure of utterances;

– delimitate the boundaries and

provide cues for independent recognition of significant features of similarity or difference; if necessary – to hint what features and where should be looked for.

Let us give some examples.

Task 1. Describe such widely spread mathematical notions as numerical equality and numerical inequality on your own (Table 1).

Instruction to the task. Do the exercise according to the following plan.

– Consider the objects given in column 1 of the table.

Table 1

Mathematical objects	Common feature	Differentiating feature	Definition
Numerical equality 2 + 3 = 5 6 = 7 – 1 8 – 3 = 4 + 1 (6 ÷ 3) + 2 = 4	Notation consisting of numerical expressions (elementary, prime or composite) and the sign of comparison	Expressions are connected by the equality sign (=)	A numerical equality is a notation consisting of numerical expressions connected by the equality sign
Numerical inequality 3 >2 7 + 2 > 7 + 1 10 < 10 + 3 8 × 2 < 8 × 2 – 1	Notation consisting of numerical expressions (elementary, prime or composite) and a sign of comparison	Numerical expressions are connected by the signs of inequality (> - greater than or < - less than)	A numerical equality is a notation consisting of numerical expressions connected by the signs of comparison “greater than” or “less than”. Note: in mathematics, a separate number is called elementary expression

– Find a similar feature for both of them and formulate a sentence reflecting this fact. Write it down in the second column of the table.

– Find a differentiating feature, formulate it and take it down in the third column of the table.

– Make up a definition of each notion taking into account the common and differentiating features.

The process of training the given technique, the same as all other techniques, should be organized gradually increasing the difficulty of exercises. During the first meeting with this technique, all steps of completion of the suggested plan and the plan itself are done in the process of dialogue guided by the teacher. Then, gradually, the last operation is resorted for independent completion; the first three steps are taken by the pupils themselves as part of group activity and are self-checked up later on, or the first three columns are filled out under the teacher's guidance and the last task is completed by them on their own (self-checked up later on). Then, two columns are left for independent completion, and the first two are filled out with the teacher's help. Then children fill out three columns by themselves, and so on. Thus, gradual formation of learning independence is being formed.

Teaching the technique of explanation of mathematical objects and their application should be started with telling about the structure of its completion and about how it is unfolded and used in reality accompanied by making up a table convenient for taking down the results of each stage of the technique. In the primary school classroom, it is advisable to provide a detailed instruction to completing tasks of this kind.

Task 2. Explain the properties of arithmetic operations and their usage (Table 2).

Task 3. Formulate the discovered dependence and explain its usage (Table 3).

Table 2

Observation of the phenomenon to be explained and discovery of connection	Formulating the sentence reflecting the discovered connection	Coding the sentence	Using the connection for calculations
12 × (7 + 4) = 12 × 7 + 12 × 4 24 × (8 + 9) = 24 × 8 + 24 × 9	To multiply a number by a sum, multiply it by the first addend, then by the second, and then add the products	a × (b + c) = a × b + a × c	6 × 13 + 6 × 7 = 6 × (13 + 7) = 6 × 20 = 120

Table 3

Observation of the phenomenon to be explained and discovery of connection	Formulating the sentence reflecting the discovered connection	Coding the sentence	Using the connection for calculations
5 + 3 = 8 8 – 5 = 3 8 – 3 = 5	If you subtract one of the addends from the sum you will get the other addend	a + b = c c – a = b c – b = a	x + 2 = 6 x = 6 – 2 x = 4

According to L. S. Vygotskiy [3], formation of any new personal entities including operations, actions, techniques, skills, and abilities is possible only in the course of activity. And the schoolchild passes through the following stages in this process:

– Primary experience of performing an action and emergence of positive motivation to perform the action.

– Mastering the algorithm of the action completion in various situations.

– Training, self-control and self-correction of the action performance.

– Control, assessment and (if necessary) secondary correction.

Application of the above mentioned stages (or steps) and methodological tools designed for the development of techniques of independent cognitive activity facilitates the development of academic independence of junior schoolchildren and turns the pupils into active participants of the process of cognition rather than passive consumers of information.

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