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Studies of Adolescents' Cognitive Abilities at School

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***Abstract*—Theoretical thinking is determined by the content operations included – content analysis, planning, and reflection. Our study is aimed at analyzing the relation between individual characteristics of theoretical thinking development in early adolescent period. We introduce the idea of the relation between formal and dynamic characteristics of thinking and content thinking operations. Content planning, which is one of the main theoretical thinking operations, is regarded as a factor of its development. The types of planning actions are distinguished according to differentiation-based positions in learning activity. The study gives the results of correlation analysis, which is used to check the relationship between the types of planning action. It has been found that children who have the polar types of planning actions (reflective-analyzing – guessing) are statistically more often characterized as those who have the polar cognitive styles. Such cognitive styles as field independence, lability, and generality are more typical for children with a reflective-analyzing type of planning action. Children with a guessing type of planning action are more likely to have other cognitive styles – field dependence, rigidity, and concreteness. Children with an analyzing type of planning action tend to have such cognitive styles as field independence, rigidity, and generality.**

Keywords—planning action, cognitive style, theoretical thinking development, early adolescence, educational activity

I. INTRODUCTION

In 2009 the Russian Federation adopted the Federal state educational standard of primary general education [1] that is based on a system-activity approach. The conception of the approach is to ensure that students' learning activity should satisfy their age and individual characteristics. The Standard says that the basic educational program of primary general education includes, in particular, students' ability to plan their actions as one of the meta-subject outcomes of education.

The education system has faced the problem of developing didactic systems and teaching methods that allow primary schools to achieve the learning outcomes required by the Standard.

This article is devoted to the psychological characteristics of thinking of children who have been trained according to the program of developmental teaching. The purpose of this study is to analyze the relation between the content and formal-dynamic characteristics of thinking in young adolescents.

II. MATERIALS AND METHODS

The hypothesis of the study is that the development level of content planning action is a factor that determines the formal-dynamic cognitive characteristics. To study the relation between the cognitive characteristics and the types of

children's planning actions the experiment was conducted in the three Naberezhnye Chelny-based secondary schools. The study was carried out in the period 2016-2019. The test subjects were students of 5-7 grades aged between 10 and 13. The total number of the subjects was 97 people.

The author-designed technique of identifying the types of planning actions (I.N. Fedekin) was used to diagnose the types. At the first stage the children were asked to do a test to diagnose the formation of a planning action. Then on the basis of the obtained results the groups of children were made up. These groups comprised the children with a reflexive-analyzing (28 children), analyzing (35 children) and guessing (34 children) types of planning.

At the second stage of the study the groups of children with different types of planning were identified to diagnose their cognitive styles. The subjects were asked to do the following tests: Luchins' test "Verbal Labyrinth" [2], "Interpretation of Metaphors and Proverbs" [2] and "Embedded Figures" Test by H. Witkin [3].

When processing the data obtained, the Pearson's chi-squared test $\chi 2$ was used as a statistical method.

III. Results and Discussions

The theory of educational activity developed by D.B. Elkonin and V.V. Davydov and the system of training based on this theory are well known in the psychological and pedagogical community. The works [4], [5], [6], [7], [8] done within this theory show that using special teaching methods, it is possible to form the foundations of theoretical thinking at primary school age. According to V.V. Davydov [9], theoretical thinking is characterized primarily from the content standpoint. This type of thinking is formed when learning a system of theoretical knowledge. This content orientation of theoretical thinking distinguishes it from empirical or formal thinking.

The philosophical perspective of theoretical thinking allows us to see that since ancient times, the issue has been arisen and always existed in connection with scientific consciousness, being its core. To be more exact, scientific consciousness includes a constructed theoretical (conceptual-discursive) model of reality, as well as a sensory-perceptual model. Theoretical knowledge as a complex set of rationalized abstractions is a special phenomenon of culture. Its mechanisms are historically developed and depend on the types of system objects studied by sciences, as well as on the features of a particular culture of values [10].

The psychological researches regard the theoretical type of thinking as the one characterized by a set of specific intellectual operations or actions, the most important among them are reflective operations. These actions include reflection, analysis, and content planning. However, the formal-dynamic, process aspect of theoretical thinking has been understudied. We can only mention the works done by A.Z. Zak. For example, one of them [11] says that the main characteristic of theoretical thinking is its occurring "in mind", i.e. content actions of this type of thinking may not be based on visual perceptions. However, this characteristic of theoretical thinking seems to be arguable.

But along with the growing interest of researchers in the issue of individualization of educational activity and theoretical thinking, it is pointed out that younger students may have some characteristics of educational activity and thinking [12]. According to L.S. Vygotsky's conception of the development of higher mental functions (the theory of educational activity is based on it), it is the individual mental function that is the result of this development, even if it is theoretical thinking [13].

Thus, there arises a reasonable question about the individual characteristics of theoretical thinking. What formal-dynamic characteristics of thinking should an individual have, whose theoretical thinking has been formed in primary school age?

The question cannot be answered without finding out to what extent the child's educational activity has been individualized. After all, it is theoretically assumed that if a child has fully internalized the structure of educational activity, their theoretical thinking has to be formed. However, a lot of studies show that individualization of educational activity is not provided for every student by the end of primary schooling. This means that theoretical thinking is not formed in every student either.

Lack of theoretical thinking is marked by lack of intellectual operations (content analysis, reflection, and planning), which characterize this type of thinking. As a rule, the formation of intellectual operations has a number of stages, so the operations of theoretical thinking in some students are still in the intermediate stages of formation by the end of primary schooling. This means that there must be differences in formal-dynamic, process characteristics of thinking between teenage students.

Types of planning operation. Distinguishing between two types of thinking, empirical and theoretical, as two possible approaches to knowledge, V.V. Davydov gave a detailed description of these types of thinking. From his point of view, a characteristic of theoretical thinking is that it is done "mainly in terms of a thought experiment, which is characterized by such a mental action as planning made by a person" [8], [9]. Therefore, we treat planning as a component of theoretical thinking, as a component of a generalized learning skill.

Our study considers the classification of the types of planning action based on differentiating the positions in educational activity [14]. The following positions of participants in collective educational activity are traditionally identified. The learning and teaching operations are shared among them [15], [16]. A "teacher" is a person who has knowledge and is aware of how to transmit this knowledge to others who do not have knowledge. This position can be taken by a professional adult, as well as by a student.

A knowledge-oriented student ("uchenik") is someone who is aware of their lack of knowledge and is able to go beyond their limited knowledge. At early school age, the main way to overcome the lack of their knowledge is to cooperate

with a teacher in class, taking the initiative. The student's independence when setting objectives to transform their own knowledge and skills and searching for the ways to achieve the objectives is the foundation of the ability to self-transformation.

An instructions-oriented student ("shkolnik") is someone who follows the teacher's instructions.

Reflective-analyzing type. The children of this type are able to recognize the conditions of the problem that definitely limit the range of possible operations, and to cut off the prohibited operations, i.e. those operations that cannot be done while solving the problem. The conditions that are not directly given in the problem, but they meet the chosen operation, show what to do when solving the problem.

The children of this type are well aware of the difference between the positions of "a teacher", "a knowledge-oriented student", and "an instructions-oriented student", so they are able to ask quite different questions when addressing different positions. Thus, the children with this type of planning ask the teacher questions about the general learning operation.

Analyzing type. The children of this type are mainly oriented to collective educational activity with their peers and with a teacher. Therefore, they can find the right solution due to group work. This group of children can act under the conditions of discovered ignorance only together with other peers. G.A. Zukerman [17] wrote about such children, "If a group, which has been given a new assignment, is able to detect the contradiction of the conceptual content as the difference of opinion of its participants and ask the teacher about the way to coordinate their views, then we can assume that this group takes a collective position of a student". However, this position is not individualized by the children of this group.

Guessing type. The children of this type are not oriented to the conditions of a problem at all, often introducing the new conditions that have not been set.

The children of this group avoid individual activity and do not know how to solve a problem together with their peers. If there is any difficulty, the children of the guessing type turn to a teacher for instructions.

The concept of cognitive style. According to [18], the term "cognitive style" first appeared in American psychology in the 1950s and 1960s as part of researches in which individual differences in perceiving, analyzing, categorizing, and reproducing the information came to the fore.

There are many current definitions of the concept "cognitive style". We agree with M.A. Kholodnaya who treats this concept in a broad way. According to her, a cognitive style is a characteristic of the way of cognitive activity; personal factors regulating cognition, thinking, etc. The concept also includes the peculiarity of a person's life path structured by setting and achieving goals [19].

The concept "cognitive style" was introduced and used by H.A. Witkin in the 1950s and 1960s. He treated cognitive style as the way of perceiving, processing, analyzing, systematizing, and structuring information. He believed that an individual's cognitive style could be identified by solving standardized problems [20]. In a broader sense, due to these mechanisms individual's mental activity in general, handling the new data, and educating in particular are available. Some authors connect cognitive styles with intellect, and other scientists think that they are its integral part [21]. G. Allport considered cognitive style to be an instrument for an individual, i.e. the ways and means to achieve their goals [22].

A. Adler, an Austrian psychologist, regarded the concept "cognitive style" as a stable individual characteristic of cognitive processes that determines the use of various research strategies [23]. J. Bruner, an American psychologist, also used the concept of strategy that is setting and verifying hypotheses in problem-solving. A strategy is an individualized system of the ways to operate with information and form response behavior, aimed at solving a specific problem and searching for a solution. The operational structure of a strategy can be specified when searching for a solution. A strategy is determined by the cognitive style in specific problem-solving [24].

Thus, cognitive styles indicate the typical ways of perceiving, memorizing, thinking, and problem-solving preferred by a particular person. They are regarded as broad style characteristics of behavior that are end-to-end characteristics of personality abilities shown in many kinds of activities and patterns of action [25]. This approach is of great interest in the issue under discussion. Therefore, a number of authors [18], [26], [27] point out that a cognitive style, in contrast to an ability, relates to the way rather than to the level of activity performance.

Our study considers the following styles: field dependence – field independence, rigidity – flexibility of cognitive control, generality – concreteness of thinking [28].

The technique developed by I.N. Fedekin (2001) was used to diagnose the types of planning action.

The summarized research findings are shown in tables 1–3.

TABLE I. SURVEY RESULTS ON THE "VERBAL LABYRINTH" TEST, NUMBER OF PEOPLE

Cognitive style	Type of planning				
	Reflective-analyzing	***Analyzing***	***χ2 Pearson***	***Guessing***	***χ2 Pearson***
Rigidity	2	29	35,67	34	54,37
Lability	26	6		–	

TABLE II. SURVEY RESULTS ON THE "INTERPRETATION OF METAPHORS AND PROVERBS" TEST, NUMBER OF PEOPLE

Cognitive style	Type of planning				
	Reflective-analyzing	***Analyzing***	***χ2 Pearson***	***Guessing***	***χ2 Pearson***
Concreteness	–	11	10,66	31	51,06
Generality	28	24		3	

TABLE III. SURVEY RESULTS ON THE "FIELD DEPENDENCE – FIELD INDEPENDENCE" TEST, NUMBER OF PEOPLE

Cognitive style	Type of planning				
	Reflective-analyzing	***Analyzing***	***χ2 Pearson***	***Guessing***	***χ2 Pearson***
Field dependence	2	7	2,1	30	40,43
Field independence	26	28		4	

Correlation analysis was used to handle the results obtained, namely, the criterion of agreement of Pearson distributions $\chi 2$ at the significance level $\alpha=0,001$ is used as an indicator of the closeness of the relationship between the values "type of planning" and "cognitive style" [29]. All the dimensions were significantly different at this level of significance, except for the similarity between the reflective-analyzing type of planning and the analyzing type in field dependence–field independence styles.

Luchins' test has resulted in the following finding: the children with a guessing type of planning, as a rule, transfer the way of solving previous problems to the test problem, without searching for a new, rational way of problem-solving. Here one can observe cognitive rigidity. Conversely, the children with reflective-analyzing and analyzing types of planning solve the problem in a new, rational way, showing cognitive lability.

The data obtained are also confirmed by the survey results on the "Verbal Labyrinth" test. The children with a reflective-analyzing type of planning, as a rule, solved verbal tests in a short period of time, despite the lack of a universal algorithm for solving problems. It proves their lability. The children with guessing and analyzing types of planning, as a rule, spend more time to solve problems. They are not focused on the conditions of a problem at all, introducing the new conditions that have not been set. This is a characteristic of the guessing type of planning.

When doing "Interpretation of Metaphors and Proverbs" test, the children with a guessing type of planning, as well as most children with an analyzing type of planning, demonstrate stereotypical thinking. It is difficult for them to switch from one proverb to another when interpreting them. They do not know how to abstract from a specific situation and to purposefully identify a number of other situations matching this metaphor or proverb. A person goes and sees a gold thing. He thinks, I'll sell it and get some money, but it turns out that it is not gold". The proverb "Like father, like son" was also explained by the children depending on the specific content: "The son is like his father", "He lives near his father".

The children with a reflective-analyzing type of planning, as a rule, without visible effort, understand the figurative meanings of proverbs and metaphors easily formulate them and adequately transfer them to other situations. They demonstrate the ability to perform the following two operations: the ability to abstract from a specific situation and the ability to identify a number of other situations matching this metaphor or proverb.

When being tested for field dependence–field independence, the children also exhibit different behavior. Younger teenagers with a guessing type of planning often answer incorrectly, impulsively. The children with a reflective-analyzing type, as a rule, at first calmly and carefully think, and then show the correct figure.

In addition, it should be pointed out that when doing the tests, the children with a guessing type of planning keep a closer psychological distance: they tell the experimenter about themselves, ask the experimenter questions that are not related to this survey. Conversely, the children with a reflective-analyzing type listen carefully to the instructions for the tests (as a rule, they understand them at first explanation), follow them properly, and focus on them when completing the tasks, without being distracted by different things (the noise outside, a fallen experimenter's pen, etc.).

IV. CONCLUSION

The study shows that younger adolescents with different types of planning action have different cognitive styles. The relation between the types of planning and the cognitive styles is established:

1. Children who have a reflective-analyzing type of planning are characterized by:

- taking account of the conditions for problem-solving;
- being more likely to be field independent;
- showing great lability of thinking;
- having a more generalized thinking, being able to abstract.

2. Children with a reflective-analyzing type of planning are characterized by:

- introducing the new conditions without being focused on the given conditions;
- being more likely to be field dependent;
- showing rigidity of thinking;
- having more concrete thinking, being unable to abstract.

3. Children with an analyzing type of planning have intermediate characteristics when compared to the other two polar types of planning action. Children with this type of planning are characterized by:

- doing the prohibited operations when solving a problem;
- showing a greater rigidity of cognitive control, but at the same time demonstrating a greater ability to rearrange mental processes, i.e. they are unable to find an error, but when another person points to it, they are able to correct this error;
- being more likely to be field independent;

- having more generalized thinking, being able to abstract.

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