MANIFESTATION OF DIVERGENCE AS A SPECIFIC FEATURE OF THINKING

Veselina Ivanova[1], **Maria Temnikova**[2]

Abstract:

INTRODUCTION: The question of intellect and its development is an important topic for contemporary pedagogy science. The approach to education from this point of view gives a better idea regarding its social-cultural and psycho-pedagogy dimensions.

AIM: The research study systematized and presented theoretical concepts as well as certain practical aspects based on the specifics of developing education through the process of solving mathematical tasks.

METHODS: To achieve the aim the following methods were used: analysis of the content; pedagogical observation; pedagogical experiment; method for determining the standard for success and level of correlation.

FINDINGS AND RESULTS: The results received from the theoretical and the experimental work demonstrated that a divergence occurs through the process of solving mathematical tasks both as a conceptual foundation for the development of skills and a pre-requisite for assuring the so called "I-inclusion" of the student.

CONCLUSIONS: The result of the research in the theoretical, methodological and practical aspects are focused on integration with the intellectual development of children and school students**.**

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Introduction

Discovering the possibility to synchronize education which develops intellect with the scientific knowledge of the intellect becomes one of most important problems of the contemporary pedagogy science.

A quick view on the variety of understandings regarding the nature of the intellect shows significant disagreements in this respect. P. Petrov defined the process as chaotic. According to the same author "the logical conclusions on the surface of the empiric studies are still not sufficient", (Petrov, 2013, p. 169). This reason as well as the one related to the dominating function of different psychological components leave the question of the development of a hypothesis regarding the manifestation of the specific characteristics as well as of the characteristics of the intellect open for further scientific discussions.

The main concepts regarding intellect development through the solving of mathematical tasks are well known. The development of the intellect also can be seen in relation to cognitive and general cultural abilities of the person as well as in the relation of intellect-skill, etc.

In this context the psychometric approach to the problem of the intellect becomes the basic one.

The aim of the experimental work is to systematize and present theoretical concepts and certain practical approaches based on the specifics of developing education through the process of solving mathematical tasks.

The object of the study is the educational process of the subject "Education in thinking through solving mathematical tasks" in the IV course of bachelor's degree students.

The **subject** of the study is the influence of a dedicated set of mathematical tasks on the development of divergent thinking of the students.

1. Divergence as a main category in the cubical model of the intellect offered by Gilford

It is stated that the geometrical model of the structure of the intellect offerd by Gilford is a priori theory presenting the intellect in its more complicated aspects. The 120 factors identified by the author in the model were derived as a result of mechanical combination of categories from the three dimensions of the intellect – *operations, content, products* (Druzhinin, 2000, p.28).

In respect of *operations* which include the following psychological processes: *knowledge, memory, divergent thinking and assessment* many researchers consider differentiation of the thinking into *divergent* and *convergent* as the main achievement of this theory. According to Guilford divergent

[1] Trakia University – Stara Zagora, Faculty of Education, v_g_chipeva@abv.bg
[2] Trakia University – Stara Zagora, Faculty of Education, mpt66@abv.bg

thinking and namely the ability of a person to create multiple solutions on the basis one and the same data, is foundation for creativity.

2. **Divergence in the structure of understanding**

Binet and T. Simon adopted the concept that intellectual development almost does not depend on education and is a process of biological maturing of a given psychological functions. The test created by them and representing in its nature a series of tasks with increasing difficulty for studying attention, memory, the imagination, thinking, etc. of children between 3 and 13 years old, later provoked Binet to discover a connection between intelligence and task solving. The author segregated four types of operations: the setting of a certain goal, understanding, finding a solution (including discovering a methodology) and self-assessment. (G. Piryov, 1985, p.38)

According to St. Peev the *understanding* of educational tasks includes mental activities like: insight vision, verbalization, explanation of a particular event from different points of view; analysis and synthesis, comparison, generalization, abstraction, etc. that lead not only to clarification but also to creative solving of a given mathematical task (St. Peev, 1987). In the context of this topic it is interesting for us to follow the below interconnections and trends:

- Partial – complex and system analysis;
- Deep and analytic – full synthesis ;
- Demonstrative – mental comparison;
- Isolating abstraction (separate concept) – disintegrating abstraction / purposeful separation of the important from the non-important;
- Demonstration-acting /general visualization/ - image presentation-terminology (show images) - terminology/image presentation (scientific terminology, rules and laws) ;
- Partial concretization (within the limits of the known facts) – full concretization (beyond the limits of the known facts);
- Discover the strong and the weak sides of a phenomenon, identify the leading parameters of a given system in synergetic aspect

3. **Divergence and assessment during task solving**

We consider differentiation of the operation "assessment" as an important point in the theory of Gilford. Its wide application in the mental activity of the person is well-known and especially its relation to the identification of the truthfulness of solutions, adequacy of the images and the knowledge about the reality (for example, its immense role in the heuristic programming of a Chess play).

Efficient task solving requires deployment of assessment as a cognitive process as well as the automation and the instantaneous choosing of the idea – "candidate" for the solution. Solving of one task can be done in different ways on a global level using different means from arithmetic, geometry, algebra, etc.

Studying the activity "solving of mathematical tasks" and especially its heuristic component. Petrov got the conclusion that the role of divergent thinking for the effective search of solutions is confirmed in a greater extent. (as per Gilford terminology)

P.Petrov studied the task solving process in its heuristic aspect (from a cybernetic point of view) as *"generating multiple ideas for solving and their restriction".* Practically, he puts an accent on the necessity of *"skilful work with multiple hypotheses and a multi-optional search for a solution when solving a certain task*" (P. Petrov, 1996, p.9)

We believe, based on the concept presented by Lomov and Sourkov (1980, p.202) and namely the *"efficiency of the application of the hypotheses for solving of tasks depends on those conditions which determine the balance between the prognosis processes and the control operations (activities)"* that certain suggestions related to "divergent thinking" can be introduced.

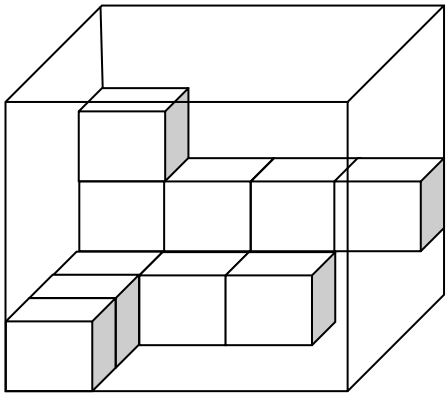
- ✓ The relation to the terminology "prognosis" can be clearly seen;
- ✓ Control and assessment activities take part on earlier stages of the activity "task solving";
- ✓ Management of the "solving" process requires verbalization of some approaches through which the prognosis and control operations are performed.

The new methodology of work includes a series of mathematical tasks, solving of which would facilitate the development of divergent thinking of the students. Further in this article we will show some

examples of such mathematical tasks. An analogical series of tasks are included in the methodology system of work propose by us.

Task: Milla has got a cube with 4 cm sides and several smaller cubes with 1 cm side. She built a structure from the small cubes and put it inside the big cube. How many more small cubes can Milla put in the big cube?

Figure 1: Drawing to Task 1



Source: Bogdanova, Temnikova, Lubenov, (2015)

The students who are trying to solve this task do not aim at the generation of multiple ideas but are trying only one idea for solving the task. Weak transversality of the skills that contain multiple perceptive components is observed. The students need to demonstrate strong reflection on the divergence as a specific feature of the skill to solve mathematical tasks.

Another **task** included in the methodology system of work is: There are in total 8 apples which are put in two bowls. When Maya и Vanya take out 2 apples from the second bowl and three apples from the first bowl are transferred to the second bowl, the number of apples in the two bowls became equal. How many apples were there initially in the first bowl?

The suitable break down of the solutions of the mathematical tasks-components and synthesis around the main terminology, that has got explanatory and regulatory functions towards the rest of the solutions, leads to operability and heuristics of the analytical method of reasoning that is used for task solving.

The possibilities to choose the implications where the reasoning and the conclusions follow one after another facilitate purpose fullness of the activities and active participation in the task solving process. The logical explanation of the analytical method of reasoning and the highest degree of verbalization of its structures of application show that the students can participate in the process of construction of this method.

The following mathematical tasks are also included in the new methodology system of work:

“An insect started crawling up a tree which is 17 m high. Every day it is crawling up 5m, and every night it is crawling down 2m. After how many days will the insect reach the top of the tree?”

We believe that for the purposes of finding of possible mathematical task solutions using different methods and ideas is the basis of the heuristic search of such solutions in our model of work. Discovery of new techniques for solving of mathematical tasks facilitates the orientation activity of the students and increase the purposefulness of the task solving process.

Results

60 students from the Pedagogy faculty of the Stara Zagora Trakia University in Bulgaria studying Pre-school and Primary School Pedagogy and Primary School Pedagogy with Foreign Language took part in the research study. Two tests were used during the experimental work each having 10 mathematical tasks. One of the tests is for Entry Diagnostics and the one is for Exit Diagnostics.

The results of the Entry Diagnostic demonstrated that 31,4% of the students solved the tasks of the test, 56,3% failed and 12,3% partially solved the tasks (hesitated). These results show poor development of

the spatial imagination of the students. Explanation can be found in: poor transversality of the skills that have multiple perception components; lack of strategy for training receptivity.

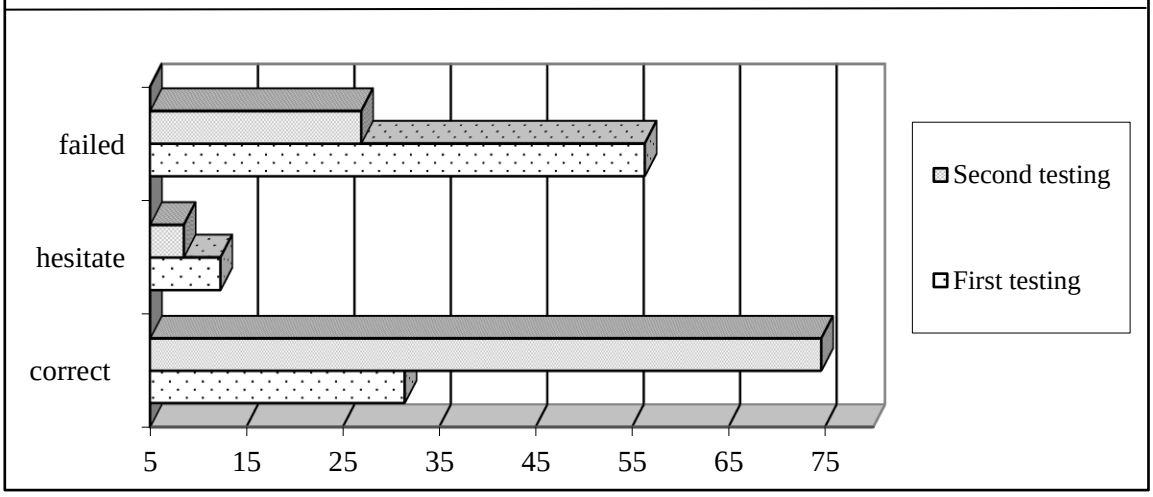
Figure 1 presents the results from the experimental work (in marks):

Excellent – insignificant mistakes are done, more that 61% of the tasks from the test are solved;

Good – mistakes are done but between 31% and 60% of the tasks from the test are solved;

Unsatisfactory – major mistakes are done. Below 30% of the tasks from the test are solved.

Figure 1: Assesstment of the results of the students who participated in the experimental work (in percent)



The results of the Exit Diagnostic showed that following the applied new methodology system of work for education,the percentage of the students who correctly solved the mathematical tasks increased to 74,6%, those who hesitated decreased to 8,5% and those who failed decreased to 26,9%. A statistically significant difference between the results from the Entry and the Exit Diagnostic was identified.

Conclusions

The newly developed methodology system of work puts the student in the center of an active process where they design their terminology and ideas based on their own knowledge and previous experience.

Following its application students achieved a higher level of internal goal orientation, efficient development divergent thinking with a trend for transversion in different ages and activities.

Development of the divergent thinking of the students helps for: development of skills and abilities for transversion through the solving of restricted (small) number of mathematical tasks in similar areas, development of a work style that creates immanent motivation for the solving of mathematical tasks.

The result of the research work in theoretical, methodological and practical aspect is focused on the integration with the intellectual development of children and school students.

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