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THE ROLE OF THE GRAPHIC METHOD IN SOLVING ARITHMETIC PROBLEMS AND STIMULATING THE STUDENTS' CREATIVITTY

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Abstract

The teacher should stimulate the student to think, make efforts of abstract inner personal reflection, undertake mental actions of research and truth discovery, elaborate new knowledge, thus overcoming the threshold of concrete-sensorial, intuitive actions in solving Arithmetic problems. This article aims at highlighting the relevance of using the graphic method in stimulating the students' creativity with a view to optimizing the instructive-educational process. The research undertaken relies on the following hypothesis: applying the graphic method in solving problems of Mathematics enables efficient learning of the taught contents, leading to the motivation of learning, educating attention and stimulating creativity, as well as enhancing school performance. Our paper highlights the inner harmony of Mathematics, which is able to raise awareness of the fact that there are attractive mathematical problems and efficient solving methods, for the understanding of which we need neither special talent nor training which exceeds the level of elementary grades.

Key words*:* creativity, elementary school, graphic method, Mathematics, pedagogical experiment, solving problems

1. Introduction

Mathematical education is defined by effort, active participation in the process of solving various problems through research, hypotheses, strategy building, verification and argumentation. Teachers for primary education should catch and retain the students' attention during the teaching

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activity, raise their interest and curiosity through methods able to shape their character, discover those stimuli which may regulate and educate their attention, in order to succeed in transmitting the knowledge needed to the future adults of the country. If the primary school teacher holds scientific, pedagogical, methodological and research training, then he will use the graphic method with artistry and competence in solving mathematical problems, being able to motivate students through a complex stimuli which may contribute to educating their attention.

The teaching activity requires serious methodological training, because this profession is not about improvisation, but about hard work to innovate the teaching methodology. Teaching is not done according to a template, but is invented, rules are not repeated stereotypically, but considered logically, there is no process of hurried drawing, but one of accurate construction, there are neither constraints imposed on the students, nor wrong freedoms. There is no gap between theory and practice, but the attempt to create as many bridges as possible.

2. Theoretical reference framework

2.1. Solving problems through the figurative method

The method which represents the quantities from a problem and the relationships among them by means of graphic elements or drawings and schemes is called the *figurative method*. By solving a problem through this method, we resort to reasoning, using the concrete meaning of the operations. The corresponding figuration of the problem should be a schematization of the statement, in order to focus attention upon the mathematical relations instead of upon all the concrete aspects, like in a photo.

The figurative-graphic application may resort to any category of graphic elements and combinations among them, on condition that they be suitable to the nature of the problem data and accessible or, above all, useful to the solver. Thus, there may be used:

- drawings representing the action of the problem and its component parts;
- various geometrical figures: the straight line segment, the triangle, the rectangle, the square, the circle;
- the schematic figuration of the mathematical relations among the problem data;
- various conventional signs – usual ones or established by agreement with the students, according to the case;

- letters and combinations of letters;
- simple graphic elements: points, oval lines, small circles etc.

2.2. The role of solving and composing problems in stimulating creativity

Based on the idea that the study of Mathematics in primary school aims not only at making children consistent with the elementary notions of Mathematics and building certain calculus skills, but also at developing logical-mathematical thought and, above all, creative thinking, special attention should be given to the problems whose solving requires atypical, invented strategies, as well as problem composition.

A problem demanding creative effort from one student may be easily solved by another student, who has solved similar problems and knows the work strategies, having a well-structured mental image of the schemes with which he/ she operates. Therefore, a problem is creative or not according to the student's age, experience and intellectual capacity. Hence, there is no single recipe for all the grades. The primary school teacher should carefully select exercises and problems, according to the class level and even the level of each student.

The student, especially at the age of 7-11 years old, does not manage to handle all the great difficulties he may be challenged with, all at once. The student should be gradually prepared and exposed to increasingly difficult problems. Therefore, as we shall further see, we have used exercises and problems to gradually train students, in order to solve complex and difficult problems successfully.

The creative process is very complex and diverse. It comprises multiple aspects whose education constitutes different operational objectives. Hence, the diversity of the problems used, each contributing to the intellectual training of the student. Problem composition constitutes a higher step in building creative thinking, connecting theory and practice. Through this activity, students observe a correlation between exercises and problems, which strengthens the conviction that exercises and problems are closely connected activities.

In order for someone to elaborate the text of a problem, it is necessary to identify the corresponding context, imagine the action, select the figure data, so that they may be in agreement with the reality, establish corresponding arithmetic solutions among the data and formulate the question of the problem.

We may say that the ability to compose problems is the touchstone marking the development of independent and original thought in mathematical activities. This activity starts in the 1st grade,

but due to the children's reduced capacity to elaborate judgments, it is necessary to gradate it. We have found that the students from the 1st grade encounter a series of difficulties in composing problems. Transposing the actions from reality into problems is done with difficulty and the occurrence of extra words, disagreement between words, formulation errors. All these are due to the reduced mathematical vocabulary of the students in the 1st grade. Several procedures may be used in the activity of problem composition.

3. Design

3.1. Research objectives

Solving Arithmetic problems through the graphic method plays a particular role in stimulating creativity. Catching and retaining the students' attention during any teaching activity shows the teacher that he/ she has succeeded in raising the students' interest, which contributes implicitly to motivating them for learning. Our research aimed at: - discovering the complex stimulus (the graphic method in solving Arithmetic problems) able to stimulate the students' creativity, educate the students' attention and interest during the classes of Mathematics; - finding the best teaching strategies contributing to achieving a higher performance in solving Arithmetic problems by means of the graphic method and not only; conducting a psycho-pedagogical research which may ensure the validation of the proposed hypothesis.

The paper aims at presenting some of the problems raised by building the primary school student's creative capacity. It investigates the primary school student's creative potential, possible ways to evaluate it, analysis of the results obtained and their interpretation. We have traced the evolution of the creative potential under the circumstances of focusing the teaching of Mathematics on activities requiring, above all, creative thought. The obtained results have provided a frame reference for the subsequent use of certain methods to stimulate creativity.

The main research objectives are following:

- knowledge of the students' initial level of acquiring mathematical notions with natural numbers from 0 to 1000;
- designing and conducting an educational process focused on highlighting the role of the graphic method in solving Arithmetic problems and stimulating the students' creativity during the teaching and learning of the natural numbers from 0 to 1000 (reading, writing, comparison, approximation, addition, deduction) with and without crossing the order;

- evaluation of the graphic contribution in solving Arithmetic problems to enhancing school performance;
- identifying the progress achieved by the students in terms of their knowledge, skills, capacities), as a result of administering the progress factor;
- formulating the conclusions with the role of improving future teaching activity.

3.2. Hypothesis

In initiating the research, we relied on the conviction that using the graphic method in solving Arithmetic problems and certain efficient teaching-learning methods during the lessons of Mathematics – methods able to catch and retain the attention of students – leads to achieving a higher performance of learning. In our research, we started from the hypothesis that: *if the graphic method is used in solving problems of Mathematics, then the efficient learning of the taught contents is ensured, generating learner motivation, educating attention, stimulating creativity, enhancing school performance.*

To demonstrate the study hypothesis, we have conducted an experimental research for which we have used a series of methods, such as: observation, experiment, analysis of the products of the activity, knowledge testing.

3.3. Variables

The independent variable consists of the use of the graphic method in solving problems of Mathematics. *The dependent variable* is the productivity of learning reflected in the results obtained in the summative evaluation tests, applied to the experimental class of students.

3.4. Research methods

The applied research methods have been the following:

- *Methods and techniques for data collection:* observation; formative pedagogical experiment; analysis of activity products; the technique of the knowledge test;
- *Mathematical-statistical methods:* analytical tables; synthetic tables; graphic representations: circular diagram, frequency polygon, histogram; statistical indices: mean, median, module; indices of variability: amplitude, mean deviation or the mean of absolute deviations; dispersion or variance, standard or type deviation, the method of the ranks.

In conducting this experiment, we have covered three phases: initial evaluation, formative assessment, summative assessment.

a. Initial evaluation, achieved through the knowledge test, may provide data on the minimal level of acquisitions regarding problem solving with operations of the same order. This initial evaluation was applied following the revision of the knowledge from the 2nd grade.

Following the recording of the results, we have drawn the following conclusions regarding the acquisition of mathematical knowledge: students encounter difficulties, both in solving multiplications and divisions and, especially, in solving and composing problems. The mean of the class level was 6.10, this representing the starting point in conducting the research undertaken. In applying formative assessment, during the classes of Mathematics, there was used the graphic method in solving Arithmetic problems, as well as active-participative teaching methods, with a view to building and developing the students' intellectual working skills, achieving performance and eliminating knowledge gaps.

b. The formative evaluation has enabled the identification of weak, critical points at the end of each training sequence and, as a consequence, the adoption of recovery methods with some students and the improvement of the instructive-educational process. It is constituted as an efficient tool for preventing failure situations, therefore it could also have the function of a progress evaluation. Formative assessment has been used to identify the results obtained by each student, observe the progress and regress of each student, in order to be able to take the correct recovery measures. By applying this test, we have looked at the extent to which the students have acquired the calculus algorithm for operations with natural numbers, of finding unknown numbers and solving problems.

c. Summative assessment

Following the recording of results, it was found that the students know the calculus techniques, the order for performing operations, how to solve and compose problems according to certain requirements, by using the graphic method. The weak points are largely due to lack of attention and less to lack of knowledge. The mean of the class was 8.05 in the final evaluation, which means that visible progress has been achieved. The experiment is known as the most important research method, because it provides precise, objective data. This will be framed within the category of the natural, psycho-pedagogic, formative experiment. The pedagogical experiment provides quantitative and qualitative data, with an increased degree of precision, because they will be processed and interpreted by means of the statistical-mathematical methods and

techniques. The content of the paper is a combination of information from the literature and some elements of professional experience related to stimulating the students' creativity through problem solving. We believe that Mathematics is one of the fundamental disciplines with special creative valences, which the teacher may exploit with a view to stimulating creativity.

To establish the students' performance and, particularly, their creative potential, there have been elaborated tests on Mathematical algorithms, depth, divergence, originality and creativity. By means of these tests, initial, formative and final evaluations have been conducted, the results being recorded in analytical and synthetic tables and graphically transposed into frequency polygons, histograms, circular comparative diagrams, the data being interpreted and turned into a basis for improving the instructive-educational process.

In the complex process of evaluating the school results at Mathematics, a first direction of action is imposed by the need to efficiently and realistically design a training sequence. For example: approaching the chapter *Solving problems through the graphic method*, from the 3rd grade textbook, should be preceded by a diagnosis test, to identify the level of acquisitions and the possible gaps in the students' knowledge of Arithmetic, as established by the 3rd grade school syllabus. In eliminating the gaps, there will also be a constant updating of the knowledge involved in the content of the new learning from the 4th grade.

Evaluating the performances of students is achieved according to the proposed operational objectives and is needed in order to: know the initial level in approaching a sequence of training, with a view to the efficient organization of the new learning activity; confirm the achievement of the objectives proposed for a certain teaching unit; establish the level reached by each student in the process of building the set of skills implied by the objectives.

Confirming the achievement of the proposed objectives is done through the summative and formative evaluation of each teaching unit. Designing the teaching unit, defining the lesson or unit objectives cannot be realized without establishing the performance criteria indicating their achievement. The evaluation act contains items (tasks, questions, statements, etc.) which materialize the previously established performance criteria.

For grades 1-4, in the system of mathematical education, an evaluative conduct of the teacher is shaped, which meets at least three appreciation criteria (not of proper measurement), namely: - by relating to a norm, imposed by the demands of the school syllabus (defines the conditions for the efficiency of training and learning); - by relating to the level reached by the students in the class or in the reference group (defines the conditions for the efficiency of teaching and learning);

- by relating to the possibilities of each student, this being a process evaluation. The tasks proposed to students should be gradated, differentiated and varied, so that they may relatively cover the entire range of possible situations in a given case.

3.5. Participants

The research undertaken was conducted during the 2011-2012 school year, on a single experimental sample consisting of the students from the 3rd grade C, from "Ion Creangă" School of Bacău. The experimental group consisted of a number of 15 students, 8 girls and 7 boys, and was homogeneous in terms of the students' age, level of intellectual development and background. Some of them have satisfying, while others have reduced material possibilities, coming from families of workers, with elementary and middle studies, who show an interest in raising and educating them, constantly maintaining the connection with the school, responding to the demands of teachers in terms of the instructive-educational process.

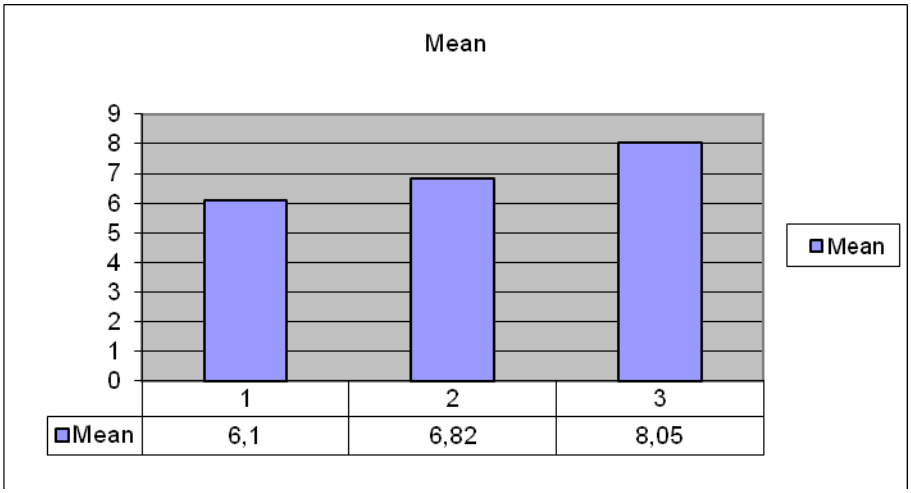
4. Comparative analysis, data processing and interpretation

Comparing the mean of the students for the three tests, we obtain the following table (Table 1).

Table 1. Presentation of the average for the 3 tests

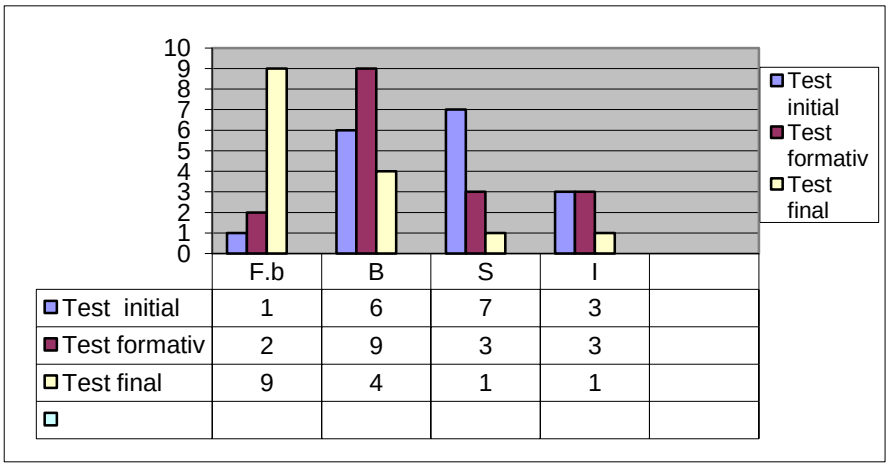
Mean		
Initial test	Formative test	Final test
6,10	6,82	8,05

By representing the histogram of these means of the results, we obtain (Histogram 1).



Histogram 1. The students' results obtained at the 3 tests

By representing the frequency polygon of these means of results, we obtain the Frequency polygon 1.



Initial test; Formative test; Final test

Frequency polygon 1. The graphical representation of the students' results obtained at the 3 tests

Comparing the results obtained to the applied tests, we may track the progress of students following this experiment. The final test was designed so as to comprise the knowledge acquired during all the learning units planned for the 3rd grade.

This experiment has confirmed the fact that the students may acquire, understand, become consistent with the content of certain basic notions of Mathematics, in different rhythms and levels, determined both by the intellectual psychic particularities and their educational factors. By applying the heuristic models a gradated and judicious effort was made at training the students' thinking. Independent and well-organized work was aimed at, and achieved, the training of students for the following educational levels. Thus, the "progress factor" involved in the proper activity of solving Arithmetic problems through the graphic method has significantly contributed to building efficient intellectual work skills and improving the school performances of students at Mathematics.

The individualized activity takes into account the work rhythm of each child, his/ her abilities and physical and intellectual strength, tracking the progress of each student based on their own activity. Differentiation is the key to full success in school teaching and learning due to the fact that students with special skills acquire knowledge more than anticipated by the syllabus, and the others acquire more knowledge than in the situation of no help provided by solving differentiated tasks, therefore resulting in their acquisition of the knowledge established by the syllabus. Applying differentiation to the students' training, we encourage the early identification of cognitive interests, special skills, providing the bests conditions for cultivating them, so that each student may experience the feeling of success.

Conclusions

Based on the reference literature, the teaching experience and the applied evaluation tests, we have drawn the following conclusions:

- the final results reveal the progress obtained by the students in solving Arithmetic problems using the graphic method, as well as in building creative skills;

- the obtained results provide detailed information which may be taken into consideration in elaborating the ameliorative measures for students, thus: the students with reduced understanding and assimilation skills will be assigned reproductive and knowledge tasks, in order to help them achieve the objectives of the syllabus; and those with a higher creative potential will be provided with the best circumstances for building their creative skills in an unhindered way;

- by means of these tests, a very efficient inverse connection is achieved; the primary school teacher holds information about what each student knows and does not know from the respective chapter, and the students become aware of what they have achieved;

- the methods used to measure and develop the students' creative potential have generated an increase in their school performance, as well as a slight increase in the pace of their work, but have particularly contributed to building divergent and original thought;

- in the students' acquisition of knowledge, a very important role is played by independent work: during the class of Mathematics, students have to work a lot, make applicative and, particularly, mental creative effort;

- within the independent classroom activity, we should also achieve learning at one's own pace, because, in a class of students, there are several levels of thinking and working rhythms, characteristic of each child;

- the students have understood the fact that Mathematics is a science of the surrounding reality, indispensable to the various practical human activities and not just an abstract, pure activity.

All these acquisitions of the students are minimum premises for any act of creation, a basis for any future creation and of creative behaviour. We believe that the aim and hypothesis of the paper have been confirmed and that the correct solving of problems is largely due to the students' intellectual skills and the correct acquisition of the problem solving methods.

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