

PEDAGOGY

Golodiuk L.S.

Formation of pupils creative thinking in the course of their educational and research tasks in mathematics

*Golodiuk Larysa Stepanivna, Ph.D. in education, associate professor
Municipal Institution, Kirovograd Regional IN-Service Teacher Training Institute after Vasyl Sukhomlynsky
Kirovograd, Ukraine*

Abstract. The article deals with the concepts of semantic aspect of "creativity" and "creative thinking". The parameters of creativity are selected in the article. The components of educational and research tasks for the development of practical actions and operations of thought in the study of mathematics (the examples of geometric material) are examined in the paper.

Keywords: *creativity, creative thinking, creation, imaginative thinking.*

Statement of the problem. Today education is a leading factor in determining from the school years living and professional path, strategy of a human development, aimed at gaining experience in solving different life problems that creates self-confidence. During Ukraine's transition to the new state standards for primary education [6] and basic and complete secondary education [5] the school should be focused on the intensive development of intellectual abilities of students. In particular, "the primary purpose of the educational sector "Mathematics" is the development of students' mathematical competence at a level sufficient for life in today's world, the successful mastery of knowledge from other educational areas in the school, to ensure intellectual development of students and the development of their attention, memory, logic, culture of thinking and intuition" [5]. Defining the objectives of teaching mathematics the primary task is "developing logical, creative and imaginative thinking of the pupils... [5].

The above mentioned information makes it relevant to the development of students' creative thinking on the objective material.

The aim of the paper is to reveal the essence of the concepts of "creative thinking" and "imaginative thinking" through psychological and pedagogical analysis of scientific achievements of psychologists, teachers and methodologists. To highlight the options of creativity and the creative process. To simulate the process of development of practical actions and operations of thought from the examined components of the educational and research tasks.

The analysis of recent research and publications has shown that a variety of definitions, understandings and interpretations of psychological terms "creation" and "creativity" implies multiplicity of research approaches to their studying.

Theoretical and methodological foundations of the study of creativity and creation, formation and expression of creativity, their diagnosis are highlighted in the works of both domestic and foreign scholars: K. Abulkhanova-Slavskaya, B. Ananiev, V. Bekhterev, D. Bogoiavlenskaya, L. Bozhovych, L. Vygotskyi, F. Galton, J. Guilford, D. Elkonin, I. Kant, G. Kostyuk, N. Leites, T. Liubart, V. Moliako, I. Pavlov, K. Platonov, Ya. Ponomarev, S. Rubinstein, R. Sternberg, B. Teplov, E. Torrance, F. Schelling and others.

Despite the wide variety of theories, concepts, theoretical knowledge and significant generalizations the problem of creation and creativity to this day remains a poorly investigated phenomenon, the study of which is complicated by the branching of scientific approaches to this issue and the ambiguity of scientists' conclusions.

The main material. Looking at thinking as a cognitive process that is determined by indirect and generalized reflection of reality, let's flesh out the concept of "creative thinking" and "imaginative thinking".

According to the concept of creativity by J. Guilford and E. Torrens it is defined a fundamental difference between two types of mental operations: the convergence and divergence. The convergent thinking (the convergence) is updated in the case where to solve the tasks a person needs to find the right solution under several conditions. There can be few specific solutions (e.g., the set of roots of the equation), but this set is always limited [3].

The divergent thinking is defined as "a type of thinking that goes in different directions". This type of thinking allows varying ways of solving the problem, leads to unpredictable results and conclusions. J. Guilford considers the divergence operation, along with the operations of transformation and implications, to be the basis of creativity as a general creative ability [3].

Analyzing the various aspects of the concept of creativity by J. Guilford and E. Torrens we define a close relationship between the concepts of "creativity" and "creation". The issue of creativity as a creative ability is examined by a number of researchers: S. Rubinstein, C. Rogers, A. Maslow (principle of creative initiative, the activity of the individual), Ya. Ponomarev (the theory of the psychological mechanism of creativity as a unity of intuitive and logical), I. Cohn, Ye. Shorokhova (understanding the individual as a unique integral identity, which higher integration of psychological characteristics is manifested in the creation), L. Anzyferova, A. Asmolov, P. Halperin, A. Leontiev, V. Petrovskyi, D. Elkonin (the activity approach, creative activity as the main condition for the harmonious functioning of the human personality), K. Abulkhanova-Slavskaya (interpretation of the development as a constructive creative process of life), L. Vygotskyi, A. Luria (the social aspect, the cultural and historical concept), Ya. Varlamova, E. Kremer, S. Stepanov (the

psychological principle of relativity, creative uniqueness, creation in life), M. Bakhtin, D. Bogoiavlenska, I. Semenov (the motivational construct, the principle of reflexive interaction between intellectual and personal aspects), J. Berry, J. Broadbent, D. Zakharov, V. Ilchenko, J. Comenius (the formation of creative integrative thinking of students in secondary school).

Considering the notion of "creativity", which is translated from Latin as "creative, innovative", it becomes clear its identification with the concept of "creation" and the analogy with the concepts of "creativity abilities", "creative activity", "creative thinking".

Let's pay our attention to the following definition of the notion of "creativity". Thus, the creativity is seen as an ability to creation, original thinking; the level of development of the creative skills, which characterizes the person as a whole (the human capacity to non-standard, original thinking and behavior that has got creative, constructive character [9]); the activity, process or a set of specific processes (it is a set of processes that must be considered in the same context; one or more of these processes contribute to the novelty of habitual actions, including identification and formulation of the problem, development and evaluation of any decisions, in unusual or unique and high-quality and useful is combined in the concept of "creativity" [12]), the ability to the generation of many original and useful ideas (it characterizes the ability of a person to avoid the routine ways of thinking and behavior and produce a large amount of original, new and useful ideas [7]).

E. de Bono underlines that creativity is not a natural talent, but rather a skill that you can learn [4].

So, when we speak about creativity we understand the ability to produce non-standard ideas, reject in thinking from traditional schemes, solve the problem situations quickly. Creativity covers some set of intellectual and personal qualities necessary for the formation of the ability to be creative. Agreed with the views of E. Torrens, we note that creativity is manifested when we have got the lack of knowledge, in the process of perceiving the information, and ordering it to new structures and relationships; in the process of identifying missing information; in the process of search for new solutions and their verification; in the process of reporting the results.

J. Guilford identified the parameters of creativity:

- ability to identify and formulate the problems;
- ability to generate a large number of ideas;
- flexibility as the ability to produce a variety of ideas;
- originality as the ability to respond to stimuli outside the box;
- ability to improve the facility by adding details;
- ability to solve problems, that is, the ability for analysis and synthesis [3].

Hence, the creative thinking should be understood as the cognitive process that aims to generate and produce ideas for optimal solution of educational or everyday tasks.

Exploring the concept of "creation", we give the definition that accurately reflects differences in accordance with the concept of "creativity". According to A. Turynina, the creation is understood as the individual activity, and its created values which from her personal fate facts become the facts of culture [11]. Thus, the "creation" means hu-

man activity that aims at creating spiritual and material values.

As noted by D. Bogoiavlenska, fundamental spontaneity of the creative process makes it almost imperceptible to natural and science methods [1]. This spontaneity is manifested as the inability to predict the time of enlightenment and creative solution, and in the surprise of the subject of creativity, a creative idea that may occur outside the context of the purpose of this cognitive activity. That is why quite a long time oeuvres of a person was explained by a high level of general and special abilities without actually allocated creativity as a special type, identified them with mentality.

However, the researchers of mentality have concluded that there is a poor connection between creative abilities and learning abilities and mentality. It was L. Thurstone who was the first to pay attention to the creative ability and mentality. He notes that in the creative activity there are such important factors as the characteristics of temperament, the ability to assimilate and generate ideas quickly (not criticize them), that creative solutions come in a moment of relaxation, scattering of attention, but not at a time when attention is consciously focused on solving problems.

According to R. Sternberg, the creative process is possible with three intellectual abilities:

- synthetic (to avoid the usual way of thinking);
- analytical (to identify ideas that are worthy of further development);
- practical (the ability to convince people of the value of the idea).

According to P. Ebbs, the creative process is determined by four parameters: the unconscious conscious, tradition, innovation. The researcher defines the imaginative thinking as a dialectical movement in a coordinate plane of two mutually perpendicular axes: vertical (conscious-unconscious) and horizontal (traditional-new) [8].

The given range of views on the nature of the concepts of "creative", "creation", "creative thinking" and "imaginative thinking" refers to the ambiguity of their interpretations. We believe that this situation is largely determined not only by global character and complexity of the problem, but also by the different approaches to its study.

We offer practical approaches to the formation of the creative thinking in the process of solving educational and research tasks, that is an integral component of developmental education.

The solution of educational and research tasks require going beyond stereotypical algorithmic steps. Student's ability to solve the given task effectively represents the degree of his mental development, which is an important indicator of the quality of education. However, we state the fact that the number of such tasks in the control material of measurement of quality of pupils' educational preparation is insignificant. In tests, control works the most assigned are tasks of reproductive character, in the solution of which the student uses memory, used algorithms, charts, samples of solutions. We think this contradiction is due to the fact that in determining the quality of students' education, the priority is given to evaluation of the standard of educational development (its content, that is determined by learned topics, performed exercises and tasks, formed skills, etc.). The content of the standard can be formalized and measured again using the standard test

problems. Evaluation of creative and imaginative abilities of students should be made with a different kind of tasks. The results of such tasks can vary widely from the results of the regular academic tests (tests of educational achievement). This is due to the fact that creative abilities are weakly correlated with psychometric mentality and academic achievement, but at the same time play an important role in shaping the substantive competence of the pupil.

During the formation of pupils creative thinking the organization of learning activities at the lesson should be built with the support of :

- mental and practical steps of pupils to find and study the most appropriate options of the solution of an educational task;
- a significantly increasing share of pupils' self-learning of with solving the problem situations;
- enhancing the intensity of thinking in the search for new knowledge and new ways of solving educational tasks;
- to provide the progress in the cognitive and cultural development of pupils, a creative transformation of the world .

We offer components of educational and research tasks of the development of practical activities and operations of thought in the study of geometric material.

It should be noted that practical actions are external actions with real objects and mental actions (that are the part of the intellectual activity) are internal actions with images of real objects, that is with ideas and concepts about them.

Example tasks. Design and write down the pieces of advice of which, in your opinion, should adhere to when you build geometric shapes in a notebook. Write down your ideas extending the sentence below.

To construct a point, you need __. To build a straight, it should be __.

To construct a segment, you must __. To build a beam, you need __.

We offer the option of the performed task with such comment: to construct a point, you need to touch a pencil or pen or compass to the paper.

Let's look at some operational components of thinking that occur in some logical sequence. In the structure of thinking O. Vynoslavskaja distinguishes such logical operations: comparison, analysis, synthesis, abstraction, generalization, specification [2].

The comparison reveals the relation of identity and difference of things. The result of comparison can also be a classification. Quite often it serves as the primary form of theoretical and practical knowledge.

More insight into the nature of things requires the disclosure of internal links, regularities and essential properties. It is performed by means of analysis and synthesis.

During the tasks of comparison pupils make some mistakes. They can substitute, for comparing similar features for comparing different features, or vice versa. Sometimes pupils may not complete comparison of objects on one basis and proceed to a comparison on the other basis.

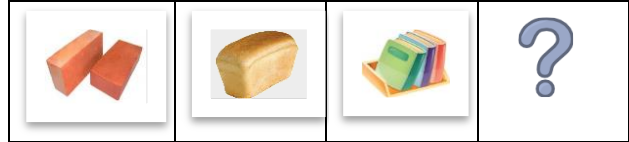
Example tasks. Suggest a way to measure the length of each line. Mark the lines and make the necessary measurements. Create a table, add the received facts and compare them. Make conclusions.



One of the options for the conclusion is the minimum distance in a straight line.

This task should be noted that students offer different ways of measuring the length of the line: for the segment and a broken line use a ruler, for a curve – a special device to measure lengths of curves and dimensional units on the maps or plans, wire, coin, etc.

Example tasks. Look at the pictures. Think what is common between the images. Try to draw a subject of environment, which, in your opinion, can extend the number of the following examples.



We offer the option the performed tasks with this comment: all items by the form can be correlated with the shape of a cuboid.

Analysis is an operation of virtual or practical dissection of phenomenon or object into its component elements.

Example tasks. Analyze the contents of definitions of rectangle and square and remember how to construct a square and a rectangle in a notebook with cells. Develop and specify the pieces of advice, which, in your opinion, should be followed for the construction of these geometric shapes. Write down your ideas into the table. Indicate the instruments you will use during the construction of the square and rectangle.

Geometric shape	Tips for building
Rectangle	<ol style="list-style-type: none"> 1. Draw a segment of the given length. 2. From the end of the segment, as from top corners, draw the angles degree scale of which is equal to 90°. 3. On the sides of the formed angles draw the segments of equal length. 4. Connect the ends of the constructed segments. 5. A built shape is a rectangle.

Tip. In carrying out this task, students must revise that the rectangle and square are the quadrilaterals. However, the rectangle degree scale of all four corners is 90° and the opposite sides are equal, and the square is a rectangle in which all sides are equal.

Thus, students analyze each definition according to the basic components: the rectangle – the quadrilateral, whose degree scale of all four angles is to 90° and the opposite sides are equal.

Since the rectangle is a quadrilateral => a geometrical figure consisting of 4 peaks, 4 sides and 4 corners.

The square is a rectangle in which all sides are equal.

Since the square is a rectangle => a geometrical figure consisting of 4 peaks, 4 sides and 4 angles and degree scale of all four angles is 90° .

Using the angles, now it is easily to construct the defined geometrical figures.

The synthesis is the construction of a set of analytical units. As a rule, analysis and synthesis are performed together, contribute to a deeper understanding of reality. Theoretical, practical, imaginative and abstract mentality in its formation is related to improving operations of thinking, first of all, analysis, synthesis and generalization.

Example tasks. Think and choose those items that will help you to draw a circle. Develop and write down the pieces of advice, which, in your opinion, should be followed to build a circle in a notebook . Draw your views in writing.

We offer the option of the performed task with this comment: advice on the design of a circle using a compass: select a point on the paper, set the compass arbitrarily, put the leg (with a needle) of the compass at the designated point, rotate the compass around a point so that the leg (with a pencil) of the compass leaves a track – a round, the built round is a border of the constructed circle.

Abstraction is an operation of the separation of a certain point (aspect) of the phenomenon, which in reality does not exist as an independent. Abstraction is performed for a more detailed study of phenomena as a rule based on previous analysis and synthesis. Abstracted can be not only properties, but also their actions, in particular ways of solving tasks. Its use and transfer to other conditions is possible only when a certain way of solving the tasks is deliberate regardless of the specific task. For example, geometric shapes: a point, line, plane, are the product of abstraction from the properties of real objects from which they originate: thickness (a line, plane), size (the points). However, the properties of lines, points (mathematical abstractions) are used to solve real practical tasks with real objects.


Generalization is a combination of essential in the subject (tentatively separated, derived by abstraction). Because of the significant in this particular subject of generalization "links" it with the whole class of objects and phenomena. The result of the operations of the generalization is the concept. In the practice of teaching mathematics basically two ways of generalization, depending on the direction of thought are used. The first method is when students compare given objects, select and form their essential common features, "leave aside" insignificant, and combine objects according to these features (generalize). At the same time students don't know general essential characteristics, they find them by themselves.

Example tasks. Express your opinion about the fact how the straight lines can be located in the plane. Write down the answer, creating a pattern.

The second method – pupils know what the essential common features are necessary to detect, that's why they

point out the data objects that are adequate to the concept formed, comparing, selecting these features in each object and combine objects by significant common features.

Example tasks. Analyze the meaningful cells. Remember what polygons you know, and fill the empty table cells.

Name of geometric figure	Graphic representation	Number of vertices	Number of sides	Number of angles	Number of diagonals
					
			4		
Pentagon					9
n-gon					

Analyze the data table. Think and try to formulate a general conclusion for n-gon, indicating the number of: vertices, sides, angles, diagonals and triangles for which it is broken by the diagonals emanating from one vertex.

Specification serves as an operation opposite to generalization. It appears, for example, that a general definition of derived judgment of belonging to a particular class of individual things and events is derived from a general definition of the notion.

Example tasks. Fill in the table .

Cuboid	Cube
1. Direct parallelepiped.	1. Direct parallelepiped.
2. All borders are rectangles.	2. All borders are squares .
	3. All edges are equal.

Conclusions. Thus, as the analysis of research papers demonstrated, creative thinking can be characterized as multifaceted and multifactorial concept. The scientific understanding of the studied concepts is dynamically updated and modified according to an increase in the volume and quality of processing of modern scientific knowledge. However, a prerequisite for high-quality education is the formation of creative thinking on the objective material. Mentioned in the article examples of the components of educational and research tasks will create understanding of practical approaches to the formation of pupils' critical thinking in learning mathematics.

REFERENCES TRANSLATED AND TRANSLITERATED

1. Bogojavlenskaja D. V. Vchera i segodnja psihologii tvorcestva [Yesterday and today, the psychology of creativity] // Dorfman L., Martindej K., Petrov V., Mahotka P., Leont'ev D., Kupchik Dzh. (red.) Tvorcestvo v iskusstve – iskusstvo tvorcestva. M.: Nauka; / Smysl, 2000. – S. 186-198.
2. Vynoslavskaja O. V. Psiholohiia : navch. posib. [The Psychology] / O. V. Vynoslavskaja. – K.: INKOS, 2005 [Elektronnyi resurs]. – Rezhym dostupu : http://www.ebk.net.ua/Book/psychology/vynoslavskaja_psihologiya/part2/2402.htm.
3. Gilford Dzh. Tri storony intellekta [Three sides of intellect] / Dzh. Gilford // Psihologija myshlenija. – M.: Progress, 1969. – 531 s.
4. De Bono Je. Šhest' shljap myshlenija [Six thinking hats] / Je. de Bono. – SPb. : Piter Publishing, 1997. – 256 s.
5. Derzhavnyi standart bazovoi i povnoi zahalnoi serednoi osvity [State Standard for basic and secondary education] [Elektronnyi resurs]. – Rezhym dostupu : <http://zakon2.rada.gov.ua/laws/show/1392-2011-%D0%BF>.
6. Derzhavnyi standart pochatkovoï zahalnoi osvity [State Standard for primary education] [Elektronnyi resurs]. – Rezhym dostupu : http://osvita.ua/legislation/Ser_osv/17911/.
7. Karpenko S. V. Instrumenty stimuljacii kreativnosti [Tools stimulate creativity] [Elektronnyj resurs] / S. V. Karpenko. – Rezhim dostupa: <http://isarf.trainet.org/materials/practicum/practicum2.shtml>.
8. Kulchytska O. I. Sotsialno-psykholohichni faktory formuvannia talanta [Social and psychological factors of talent] / O. I. Kulchytska. // Problemy ta perspektyvy formuvannia natsionalnoi humanitarnotekhnichnoi elity : zb. nauk. pr. / Akad. ped. nauk Ukrainy, Nats. tekhn. un-t "Khark. politekhn. in-t"; Za red.: L. L. Tovazhnianskyi, O. H. Romanovskiyi. – Kh. : NTU "KhPI". – 2004. – Vyp. 5(9). – S. 211-218.
9. Matveev A. Kreativnost': mysli vsluh [Creativity: thinking out loud] [Elektronnyj resurs] / A. Matveev. – Rezhim dostupa: http://www.arsvitae.ru/cgi-bin/cm/get_doc.fpl?doc_id=71.
10. Rogozina V. Pedagogicheskie uslovija razvitiia tvorcheskih sposobnostej na uroke [Pedagogical conditions of development of creative abilities in the classroom] / V. Rogozina // Vospitanie shkol'nikov. – 2007. – № 4. – S. 28-30.
11. Turynina O. L. Psykholohiia tvorchosti [Psychology of Creativity] : Navch. posib. / O. L. Turynina. – K.: MAUP, 2007. – 160 s.
12. Halperin D. Psihologija kriticheskogo myshlenija [Psychology critical thinking] / D. Halperin. – SPb. : Piter, 2000. – 512 s.

Голодюк Л. С. Формирование креативного мышления учащихся в процессе выполнения ими учебно-исследовательских задач по математике

Аннотация. В статье раскрыт содержательный аспект понятий "креативность" и "креативное мышление". Заданные параметры креативности. Рассмотрены компоненты учебно-исследовательских задач по развитию практических действий и операций мышления в процессе изучения математики (на примерах геометрического материала).

Ключевые слова: креативность, креативное мышление, творчество, творческое мышление.