

PREREQUISITES DEFINING THE TRAJECTORY OF CREATIVE THINKING

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Abstract. *Introduction.* The modern, rapidly changing world needs specialists with creative thinking skills, who are able to show rapidity, flexibility and originality in solving complex and extraordinary problems. When a specialist finds himself in such a situation where he faces extraordinary problems, he does not know how to solve them and is at a loss. It is impossible to acquire creative thinking skills without preparation. Therefore, a student, a future specialist, must be taught these skills. However, the difficulty lies in the fact that without developing students' skills such as analysis, synthesis, abstract, associative and combinatorial thinking, selective comparison, generalisation of information, system vision, assessment of ideas, the ability to ask right questions, to visualise and to draw conclusions, it will be difficult to further develop creative thinking in students.

Aim. The aim of the study is to discover the relationship between various types of thinking and creative thinking, to determine the types of thought operations and the list of prerequisites that precede creative thinking, which will contribute to the formation of creative thinking in students.

Methodology and research methods. General logical reasoning methods and some scientific research methods were applied. The phenomenological method was employed to understand the process of creative thinking. Based on the determination of the main parameters and properties of each type of thinking, it became possible to model the process of creative thinking activity, to investigate this mental process and draw certain conclusions. The use of the explanatory method also makes it possible to substantiate the need for the following prerequisites for the formation of creative thinking.

Results and scientific novelty. Based on the analysis, it was discovered that various types of thinking are related to creative thinking, the types of thought operations were determined and a list of prerequisites was proposed. The list of prerequisites includes the following types of thinking: positive, synergetic, associative, abstract, visual, algorithmic, divergent, lateral, Janusian, questioning style, combinatorial, intuitive, systemic, and critical. The research results show the importance and necessity of prerequisites for creative thinking and also determine the trajectory of creative thinking activity.

Practical significance. The research results can be useful for teachers of higher educational institutions with the aim of applying them in the learning process.

Keywords: creative thinking, prerequisites, types of thinking, trajectory of thinking.

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ПРЕРЕКВИЗИТЫ, ОПРЕДЕЛЯЮЩИЕ ТРАЕКТОРИЮ РАЗВИТИЯ КРЕАТИВНОГО МЫШЛЕНИЯ

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Аннотация. *Введение.* Современному, быстро меняющемуся миру нужны специалисты, обладающие навыками креативного мышления, способные проявлять быстроту, гибкость и оригинальность в решении сложных и неординарных проблем. Когда специалист оказывается в такой ситуации, он не знает с чего начинать и находится в растерянности. Без подготовки обрести навыки креативного мышления невозможно. Поэтому студента, будущего специалиста необходимо обучить этим навыкам. Но трудность состоит в том, что, не сформировав у студента навыков анализа, синтеза, абстрактного, ассоциативного и комбинаторного мышления, выборочного сравнения, обобщения информации, системного видения, оценки идей, умения задавать правильные вопросы, визуализировать, делать выводы, будет сложно в дальнейшем развить у него креативное мышление.

Цель исследования – установление связей различных видов мышления с креативным, определение видов мыслительных операций и перечня пререквизитов креативного мышления, которые будут способствовать его формированию у студентов.

Методология и методы исследования. Используются общелогические и общенаучные методы исследования. Применен феноменологический метод с целью понимания процесса креативного мышления. На основе выявления ключевых параметров и свойств каждого вида мышления можно моделировать процесс креативной мыслительной деятельности, исследовать данный психический процесс и сделать определенные выводы. Применение объяснительного метода дает возможность обосновать необходимость нижеприведенных пререквизитов для формирования креативного мышления.

Результаты и научная новизна. На основании проведенного анализа были установлены связи различных видов мышления с креативным, определены виды мыслительных операций и предложен перечень пререквизитов, в который вошли такие виды мышления, как позитивное, синергетическое, ассоциативное, абстрактное, визуальное, алгоритмическое, дивергентное, латеральное, янусианское, комбинаторное, интуитивное, системное, критическое, вопрошающий стиль. Результаты исследования показывают важность и необходимость пререквизитов креативного мышления, а также определяют траекторию креативной мыслительной деятельности.

Практическая значимость. Результаты исследования могут быть полезны для преподавателей высших учебных заведений с целью применения их в процессе обучения.

Ключевые слова: креативное мышление, пререквизиты, виды мышления, траектория мышления.

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Introduction

Prerequisites are a set of acquired knowledge and formed skills necessary to study a certain discipline. In our opinion, exactly prerequisites are a mandatory condition for the formation of creative thinking in students. A student needs to master the skills of various types of thinking, which are prerequisites, from positive thinking to creative thinking. Creative thinking is a higher order thinking that uses various types of thought operations at all stages of creative activity from formulating a problem to making decisions. In this study, the phenomenon of creative thinking is investigated, the necessary types of thinking are determined, and creative thinking activity is modelled.

But how is it possible to determine the trajectory of creative thinking activity? When it comes to the creative process, the majority mainly focus on the stages of this process. But, in our opinion, the problem is the lack of a set of necessary thinking skills of “prerequisites” that trigger and implement the creative thought process. This research answers the questions “What thinking skills of “prerequisites” are needed to form creative thinking?”, “What is the connection between the selected prerequisites and creative thinking?”

Literature Review

The structure of creative process proposed by G. Wallas and which is supplemented and expanded by other scientists consists of such stages as preparation, incubation, insight, and verification. But in order for the process to work and give its creative product, skills of various types of thinking are needed which will be discussed below.

Positive thinking. Thinking is purely a personal process; therefore, a person must control and manage the process that occurs in his/her head. He/she must be the subject of this action. But, in most cases, people, on the contrary, become objects, which are acted on and influenced. One becomes a conformist due to the influence of the environment (family, school, society). A person does not think about the fact that he/she becomes an object and is accepted as an object,

sometimes he/she accepts himself/herself such as an object. One believes everything that is told to him/her and agrees with what he/she is believed to be and thereby suppresses his/her thinking abilities. Why does it happen? The reason is the lack of a positive attitude towards oneself and the skills of positive thinking.

Positive thinking is based on positive psychology and is considered its applied direction. Positive psychology originates in humanistic psychology and is based on the studies of Gordon Allport, Abraham Maslow and Karl Rogers [1].

Y. M. Orlov defines positive thinking as the habit of thinking in a positive, constructive way, as the prevalence of common sense over emotions, the ability to control thoughts and calls this thinking sanogenic. On the contrary, the unconscious, inappropriate thinking in which negative emotions become chronic and as a result of which a person has a long-term feeling of unhappiness is called pathogenic [2].

Creative thinking starts up with positive thinking, with positive attitude. A person who is negatively disposed overtly or covertly is not capable of becoming creative. Due to insecurity, low self-esteem, doubt, fear and negative attitudes, a person becomes controllable, unable to solve problems or achieve goals, acts mainly on command, has a limited outlook and confidence in his/her lack of creative abilities. Thus a “negative self-image” is created that destroys itself. To embark on the path of creative thinking you need to replace your negative thoughts with positive ones, that is to move from a “negative self-image” to a “positive self-image”, from an object to a subject of thinking activity. Fear, doubt, uncertainty is inherent in everyone, but a person should not allow them to control his life and for this it is necessary to learn how to put them under control.

In the list published in 2004, Seligman and Peterson distinguished 24 positive personality traits, which were divided into 6 groups. The group “Virtues of Wisdom and Knowledge” included such traits as creativity, curiosity, openness, love of learning and perspective [3]. The parameters of positive thinking are the sense of freedom, openness, receptivity, confidence (not overconfidence), the search for ways to solve problems, initiative, the ability to freely perceive the situation, faith in one’s creative abilities. A positive attitude allows a person to create his/her own world without looking at others, provides an opportunity for self-actualisation, self-expression and self-affirmation. Having embarked on the road of creativity a positive thinking person will be able to transform both himself/herself and the world around him/her. Just as “A journey of a thousand miles begins with a single step”, so the path to creative thinking begins with an important prerequisite of positive thinking.

Isen F. M. speaks of the existence of two processes regarding positive emotions. Firstly, positive emotions enhance attention, allow you to go beyond

existing structures and notice the new properties of objects, facilitate the perception of an object from different angles, which leads to the discovery of all kinds of combinations of elements. Secondly, a positive mood eases to access the stored material in memory, that is, to more cognitive material. And this, in turn, affects the creative process [4].

The concept of positive thinking is criticised by some researchers. In their works [5, 6, 7, 8], it is reported that positive mood does not develop the ability to think, negatively affects the generation of ideas and people with a positive attitude solve creative problems poorly and are less critical and tend to not entirely correct judgements.

At such stages of creative thinking as generation of ideas and evaluation of ideas, positive thinking cannot always effectively influence the process. During the generation of ideas, it can lead to the increase of the number of ideas (fluency) than the improvement of their quality [9], and during the evaluation of ideas and decisions, it is necessary to use more critical thinking than positive. However, the use of the prerequisite of positive thinking at the initial stage can induce a person to take an active life position and get out of his depression. The method of positive thinking as a concept of personal responsibility is especially important here. A person intended to engage in creative activity must also be ready for responsibility and risk.

Synergetic thinking. In nature, in the world and in life, everything is subject to changes. Fauna, flora, humans are not what they were before, they are constantly evolving. In order for a person to understand and live in a changing, developing world, his/her thinking must also evolve and acquire a higher form. Evolution is progressive and humans also strive for the future in his/her development. L. S. Vygotsky wrote that “personality is a drama”, the true drama of our life lies in the constant denial of today’s us for the sake of tomorrow’s us. Life is a constantly ongoing process of human formation [10]. Evolution and self-organisation are the indicators of synergy. As a theory of self-organisation of complex system, synergetics presents a modern type of thinking. Synergetics studies the relationship between order and chaos and during the process of evolution chaos is converted into order through the mechanism of self-organisation. What is the relationship between synergy and creativity? Creative personality is also essentially contradictory. A creative individual can be an introvert or an extrovert, a realist or a dreamer, disciplined or playful, have great physical strength and be at the resting state. Due to mutually exclusive features a creative personality self-organises and self-builds, thereby evolving. The synergetic approach proposed by A. A. Koblyakov allows us to understand the contradictory nature of creative personality [11]. Synergetic thinking that contributes to the deep understanding of both oneself and the world around, of

self-organisation as a creative person, which helps to see the world nonlinearly, holistically and globally, develops a person's creative thinking. Through evolution the perception of the surrounding world is improved.

Associative thinking. A person perceives the world around him through sense organs and as a result of which visual, auditory, kinesthetic, gustatory, olfactory ideas and various concepts are formed in his/her consciousness. Between individual facts, objects, phenomena or events, a connection is naturally generated that is responsible for object similarity which are associations and they are fixed in a person's memory. Connections are established between mental phenomena in which the appearance of one of them in a person's consciousness contributes the simultaneous occurrence of others. Associative thinking is an important component of human mind which allows generalisation and abstraction. Associative links between any objects, representations, concepts can be different: similarity, contrast, contiguity in time and space, cause-and-effect relationships, part and whole, generalisation, subordination, addition. The associative process is also reduced to such operations as analysis and synthesis. Subconscious analyses perceived objects, facts, phenomena, and imagination synthesises into what was previously encountered. The methods of associative search contribute to the improvement of creative thinking, associations pull out the most unexpected images, memories and thoughts from memory, which expand the field of creative search, help to generate ideas. Mednick S. proposed an important theory about the relationship between associative ability and creativity. He defined creative thinking "as the formation of associative elements into new combinations that either meet certain requirements or are in some way useful". He concluded that "any ability or tendency that serves to bring mutually distant ideas into contiguity will contribute to a creative solution" [12].

The leading role of association is to connect new knowledge to existing information. It is impossible to create an idea out of nothing, any idea is related to previous ideas, relies on existing knowledge and experience. A person with a good associative memory and creative imagination has more opportunities to generate creative ideas. To do this, you need to develop associative thinking, which also depends on the degree of participation of senses, on the ability to modify existing associations, on the ability to find similarities and connections in various objects and phenomena. It is necessary to learn how to build associative rows and connections to stimulate figurative memory. Associations appear regardless of our will, and of course, they do not guarantee 100 percent the appearance of a creative idea. In general, it is impossible to predict or anticipate the appearance of an idea. An idea can appear, when associations are created, it would seem, at first glance, between different unrelated phenomena, objects in an unusual form. More associations are in memory, more opportunities for

finding various connections and more chances for generating creative ideas. Associations are the impetus for creative thinking. The process of association, as natural and necessary in any creative activity, plays the role of a kind of catalyst in solving creative problems.

Abstract thinking. If in associative thinking the perception of the surrounding world occurs through sense organs, then in abstract thinking the surrounding world is reflected without affecting sense organs and there is no need for direct contact with a phenomenon or object to obtain information. In abstract thinking, abstracting from details, concreteness, subtleties, a person analyses and synthesises the knowledge he has and, through judgments, reasoning and inference, reveals general, essential connections and relationships of things, reveals more important generalising patterns, and thus the situation is considered as a whole. Here abstract thinking is not opposed to concrete thinking. These types of thinking are not antonyms, because specificity is the property of all physical and mental things, but many of these things can serve as abstractions [13].

As a result of generalisation, the process of thinking is simplified and its efficiency and speed is increased. This kind of human thinking allows going beyond the usual frame of reference and the rules of the worldview, expanding the boundaries and looking at the situation from different angles, finding extraordinary ways to solve the problem. Therefore, abstract thinking skills are needed for creative activity. Abstract thinking confers a person with such skills as: separation of the whole into parts; connection of disparate parts into one whole; generalisation and concretisation of objects and phenomena; finding a correspondence between the general and the particular; assessment of objects and phenomena and their comparison; extracting the necessary and cutting off the excess for specific situations; defining the properties of phenomena and objects on the basis of their common features. A person with abstract logic is able to reason, think, make statements, operating not with concrete data, but with abstract concepts. A person with creative imagination is able to create abstract images that do not correspond to some real object. A person forming a thought based on several judgments about something can make abstract conclusions. With the help of the skills of abstract thinking, it is possible to find something that cannot be recognised with the help of sense organs. Abstract thinking assists the generation of creative ideas, finding a way out of a situation when it is uncertain, incomprehensible, and unknown. It can be said that abstract thinking is the foundation of human creativity.

Visual thinking. As already mentioned, our entire body participates in contact with the world. Still, it is worth noting that human perception is more of the visual nature and receives information from the outside world up to 90%

through vision. Information is processed by the brain 80% in a figurative form and 20% in a verbal form, which indicates the importance of visual thinking in the perception of the surrounding world. But, in society, it is customary to teach children to express their thoughts verbally, forcing, thereby, to express all figurative information in words, and this, according to modern researchers, fetters the creative potential of human thinking [14].

What is visualisation? Visualisation is the ability to see, imagine the image of an object or situation mentally through imagination. For imagination, information is needed, which is collected with the help of the visual organ, then selected, classified, analysed, filtered, patterns are identified, grouped, analogies are drawn, that is, visual information is processed using various mental operations and moves on to the next stage of visual mental activity – imagination. If a person, especially not bothering himself/herself with mental actions, only reproduces what he/she saw, then he/she may have problems with imagination. To imagine means to use your inner vision to see something that cannot be seen at the moment. This means that we select specific coordinates, patterns, and components that we have seen before and transform them into abstract pictures that can be manipulated in our minds [15, p. 105–107]. Thus, the information being processed passes the way from the external vision to the internal vision, and as a result, a transformed, imaginary image appears.

Clarity and concreteness are the characteristic features of visual thinking that are related to both the reproduction and transformation of an object. Concreteness is of great importance, from which there is a transition directly to the practical transformation of the object. The abilities for visualisation, imagination, transformation are the structural components of creativity and with their help we get visual images.

Visual images are multivariate both in terms of their construction and understanding them. They can be interpreted and reinterpreted in different ways. This multivariance and diversity is the soil that nurtures human creativity and contributes to the birth of something new [16]. The advantage of visual images over logic is that there is possible to combine logically incompatible things such as idea, shape, colour, background, etc. [17].

Visualisation is a simple and ingenious way to explain difficult problems and solve convoluted questions [15, p. 5]. Visual thinking is necessary at all stages of creative thinking, namely: when defining, posing a problem; when solving a problem; when searching and generating ideas. Creative thinking needs such a prerequisite as visual thinking. Namely, the development of visual thinking with the help of special practices helps a subject to struggle with the stereotype of everyday perception, with prevailing habitual beliefs impeding to see the real world that exists beyond the usual routine [18]. It should be

emphasised here that visual image is a personal product that is the result of the individual visual perception of the world, processing of visual information, imagination, and transformation. Richness, the variety of visual information, from which it will be possible to construct and transform creative visual images, depends on how deeply a person visually perceives the world and himself with all the subtleties. This requires the development of visual perception, visual memory, imagination, and fantasy.

Algorithmic thinking. It would seem that where there is an algorithm, there is no place for creativity. This is because basically the algorithm implies a system of certain mental actions aimed at solving a problem in a narrow mathematical sense. But it should be noted that algorithmic thinking is one of the important conditions for solving creative problems. Solving a creative problem cannot be carried chaotically; a certain sequence of actions is required. The specific properties of the algorithmic style of thinking include discreteness (the step-by-step action of the algorithm specification, structuring operations), abstractness (the ability to abstract from specific initial data and move to the problem as a whole), and conscious embodiment in the forms of language (the ability to present an algorithm using language) [19]. With the step-by-step structuring of mental operations and abstraction from specific data to the problem as a whole, the trajectory of creative mental activity takes shape and creative imagination develops. By indicating in the algorithms such blocks such as the description of a problem/task, contradictions, the goal of a solution, the choice of the direction of the search, the search for an idea, the analysis, the solution, the concept, it will be possible to model a creative thought process. There are many different approaches to identify the stages of a creative process, but in general, the entire creative process can be divided into large stages: problem setting, information gathering, incubation (processing information at an unconscious level), and integration (conscious work on a born idea) and verification of solutions. Based on these stages, it is possible to compose a more detailed algorithm of actions with blocks. The algorithm proposed by S. Malkin is used not only for technical tasks but also for humanitarian, economic, social and others [20]. Being an effective tool for thinking the algorithm also helps to overcome psychological inertia which is important when solving creative problems.

Divergent thinking. The terms “convergence” and “divergence” mean “to meet” and “to separate”, respectively. If we talk about them as a type of thinking, then “convergent thinking” is considered as the ability to consider one idea or answer that is the most suitable one for solving a problem, and “divergent thinking” means the thinking going in different directions based on the original problem, which can lead to non-standard solutions.

Convergence and divergence are different types of information processing and are used in the creative process. Some authors consider both divergent and converging phases to be part of the general creative process, and, in general, they are cycles of movement between these two types of information processing [21]. However, divergent thinking is preferred when solving creative problems. What is the advantage of divergent thinking and why can it become a prerequisite for creative thinking?

J. Guilford, who was the first to introduce the concept of “divergent thinking” into science, characterises it as heightened sensitivity to problems that are not of interest to others, irrelevance (logical independence of reactions from stimuli), and accuracy (completeness) – the ability to improve, to give a complete look to one’s creative product [22]. E. P. Torrance [23] added such elements to the above-mentioned list as the ability to highlight the main thing (see the essence of the problem) and resist stereotyped decisions. According to S. Mednik, divergent thinking is the lateral peripheral thinking “near the problem” and the more distant the areas from which the elements of the problem are taken, the more creative the solution process [24]. It is also necessary to note the signs of divergent thinking that contribute to solving non-standard problem:

1) Divergence, which is the essence of divergent thinking, leads to increased diversity in problem solving.

2) Divergence is an endless process of complication of any forms of existence of self-organising matter, both living and nonliving. The principle of divergence is of great importance for understanding the processes of self-organisation in general and the evolution of the living world in particular [25].

3) The ability to think in different directions indicates the independence of thinking and action.

4) Divergent thinking helps to synthesise the results of mental activity in various directions and get an original solution.

All of these divergent thinking skills contribute to developing creative thinking in general. Guilford considered the core of creativity to be divergent, “fan-shaped” thinking, in which a person does not concentrate on any one method of solution, but on the search simultaneously in several possible directions: for example, puts forward several non-trivial hypotheses at once and quickly switches from testing during the solution one to the other [26, p. 51].

Lateral thinking. In most cases human mind relies on logical (vertical) thinking and prefers predictable solutions. If the solution of complex problems does not lend itself to logical thinking, then you need to use methods of such thinking that are capable of interrupting the usual flow of logical thought. This type of thinking is lateral thinking, proposed by Edward de Bono, one of the most famous experts in the field of creativity [27]. Lateral thinking (lateral, transverse, directed to the

side) is the ability to think unconventionally, out of the box, using the maximum number of approaches to solving a problem. A problem-solving approach implies a person to look at a problem at different angles, trying to find the best solution. This approach is considered an alternative to steady progress towards the goal and often allows you to find different ways to solve the same problem [28].

It should be noted that lateral thinking is not opposed to vertical thinking; on the contrary, they complement each other. By solving creative problems, lateral thinking ensures search for new ideas, and vertical thinking checks them for logic and refines them. Edward de Bono compares these two types of thinking in this way: vertical thinking deepens the existing hole and lateral – digs a new one. You will find the best creative thinking by digging many holes that are deep enough. This suggests that a laterally thinking person is in search of new opportunities and non-standard solutions. Perception is an important point in lateral thinking. How creative the solution of a problem will depend on the depth of perception of this problem. The approach to solving the problem from different positions allows you to go beyond what is permissible. There are various methods such as addition, deletion, replacement, inversion, exaggeration, reordering, which help to break patterns and find new ideas.

It must be said that there is a similarity between lateral thinking and divergent thinking. The basic idea behind these types of thinking is to overcome old habits and move in different directions.

Janusian thinking. The term “Janusian thinking” in honour of the ancient Roman deity Janus, depicted with two faces facing in opposite directions, was introduced into science by Albert Rothenberg, the famous researcher of the processes of creativity. Janusian thinking involves the ability to actively think about two opposing things at the same time and thereby work out two disparate points of view on a subject in parallel. This type of thinking is “a key step in the process of creating scientific theories and/or discoveries of people like Einstein, Darwin, Watson, Pasteur, and Fermi” and is the essence of the creative thinking process of literary critics, poets, and philosophers [29]. From this statement it follows that the consideration of two opposite things, ideas can lead to creative solutions. To a person who thinks convergently, linearly, vertically, this may seem unacceptable. But the essence of creative thinking is just a non-standard approach to problem-solving. It is Janusian thinking that is one of such approaches, in the ability to unite opposites, to find them in the holistic structure of a phenomenon, object or event. When considering opposite things, ideas, a person has the opportunity to liberate himself/herself, to reveal his/her creative potential.

Speaking of the opposites, it is necessary to say about integrative thinking, which is also the ability to synthesise the opposites. Roger Martin

wrote: “Integrative thinking, thinking in the style “I” is the ability to respond constructively to the tension caused by opposing ideas and achieve a creative resolution of the tension in the form of a new idea that contains elements of opposing ideas surpassing each one individually instead of making a choice in favor of one at the expense of the other” [30, p. 27].

Questioning style of thinking. If the above-mentioned types of thinking are associated with the senses, then the questioning style of thinking is associated with speech and language. In general, any knowledge, any search begins with questions. Even by ancient philosophers, the formation of a style of thinking began with the questioning style of thinking. This style of thinking was proposed by Socrates and supported by I. Kant, who emphasised the art of asking questions and giving answers to them among human abilities. The same opinion was shared by the classic of hermeneutics of the 20th century H. G. Gadamer [31]. And the Finnish logician I. Hintikka wrote, “If something needs to be learnt, then we have nothing to do but ask a question” [32]. The questioning style of thinking is essential for the creative process; it helps the emergence of creative ideas. The ability to raise questions is important at all stages of the creative process: with the correct formulation of the problem and when searching and generating ideas, as well as making decisions. M. Wertheimer wrote, “Raising a productive question is sometimes a greater achievement than solving the task at hand” [33, p. 50].

Charles Landry notes that creativity is a style of thinking that is more prone to questioning than criticism, which constantly makes you wonder: “Why did it happen?”, and not be satisfied with the answer: “Because it has always been so”. According to Landry, creativity attacks not only generally recognised problems, but also what suits everyone [24].

Questions guide the thought process, stimulate imagination, trigger the process of creative problem solving, intensify the brain, and contribute to search on conscious and subconscious levels. Due to questions, thinking becomes flexible. It should be noted that it is not enough to be able to ask questions correctly, the main thing is to be able to ask the right questions, and this requires knowledge, experience and curiosity. Many discoveries, creative solutions appeared as an answer to the question “What if ...?” After all, many creative thinking techniques are based on questions such as Alex Osborne’s “Scamper”, 5W, Edward de Bono’s “6 Hats” Method, Descartes Square, Test Questions Method, and many others.

The main goal of the educational process is to teach students to think, reflect, learn, and seek answers based on the constant posing of more and more new questions. Then the knowledge gained will not be an objective in itself for education, but only the means of developing students’ creativity.

Question-answer is a dialogue. Creating something new through dialogue is also a form of creativity. The dialogic thinking and the questioning style of thinking are also somewhat similar. Dialogic thinking makes it possible to discuss various opinions easily, express oneself, contributes to world outlook.

Combinatorial thinking. Everything that surrounds us consists of various combinations. Water is made up of two hydrogen atoms and one oxygen atoms; carbon dioxide is made up of carbon and hydrogen atoms. That is, everything in the universe consists of various compounds. In the same way, by combining, connecting different elements, you can get absolutely new things that did not exist before. But for this it is necessary to develop the combinatorial abilities of an individual. And combinatorial thinking itself is agglutination (connection) of the qualities of sensory, mental and imaginary processes. It is of great importance how well the various sensory abilities are developed, how flexible, complex imagination and thinking are.

Combinatorics in its most general form is a system of methods and techniques for finding and finding various compounds, permutations, combinations, arrangements of data or given parts and elements in the order and relations determined by the goal and conditions of a certain problem [34].

Combining is a form of constructive activity of the brain aimed at finding and transforming combinations of elements of the subject's experience; has as its content a subjective structural model of past combinations of experience with an assumed combination in different combinations and can act as a way of knowing the surrounding reality. Combinatorial actions that are part of combinatorial activity are as follows: 1) manipulation – enumeration of elements to select suitable elements for the created object; 2) construction – folding of elements into an integral object; 3) completion – attaching additional parts to the main structure of the object; 4) modification – rebuilding the basic combination of the elements of the object so that, in the end, an object with new characteristics is obtained [35].

Combinatorial thinking forms the ability to search for unique combinations, allows one to find a variety of possible options. And in order to be able to combine, knowledge and motivation are needed, which is expressed in the need to learn new forms and combinations of the environment to gain new experience. Nowadays, combinatorics is used to solve many theoretical and practical problems in all areas of life, and it is especially important for solving non-standard problems, generating creative ideas.

Intuitive thinking. Basically, discoveries made, creative ideas or solutions are perceived as the result of insight. Researchers engaged in the creative process have proposed different problem-solving models. G. Wallace identified four stages of the creative process: 1) preparation (problem formulation);

2) incubation (unconscious process of information processing); 3) insight (a sudden solution to a problem); 4) verification (verification of the solution) [36]. Initially, any creative idea appears as an intuitive premonition [37, p. 62–92]. Therefore, E. Bastick [38] considered the first three phases of creative process as intuition. What is intuition and what is the role of intuition in creative process? In the concept of analytical psychology by C. Jung, intuition is a special type of perception that is not limited to the senses, but passes through the sphere of the unconscious [39]. Since ancient times, two types of cognition have been distinguished: logical and intuitive, that is, conscious and unconscious. Intuitive cognition is associated with implicit learning and implicit memory, which are the ability of a person to receive unintentionally and unconsciously, process, assimilate and use information and skills. The result of implicit learning is the formation of implicit knowledge, which is indirectly revealed when performing tasks without any awareness of the very fact of its application and is almost always manifested without the participation of attention. According to the works of Daniel Kahneman, intuition is the ability to make decisions automatically without lengthy logical reasoning or proofs [40]. On the other hand, intuition is a special type of thinking in which mental actions occur unconsciously and as a result, a sudden insight can occur in the form of a creative solution or ideas. Thanks to a special intuitive calculation, there is a leap from implicit knowledge to insight, enlightenment, and inspiration. But before the idea matures, it will take some time. And by what techniques, ways it is impossible to realise all this. People who have made great discoveries and created unique masterpieces recognise the value of the intuitive thought process. Silveira [41] confirmed experimentally the importance of this unconscious process. Some researchers consider insight and sudden insight to be one of the key moments of the creative process [42, 43], while others deny the importance of insight [44].

Intuition, being an unconscious skill, is always in demand in the creative process. Although it is impossible to explain the process of intuitive thinking, nevertheless, intuition has its own special function in creating new things. Can intuition be developed? There are no experimentally proven methods for developing intuition. Only each person, acquiring knowledge from his life experience, can develop intuitive thinking.

Systemic thinking. At first glance, it seems that it will be difficult for a systemically thinking person to go beyond an ordered system. However, many researchers find a connection between creative and systemic thinking and even consider them to be parts of a whole. When they talk about systemic thinking, such concepts as a system, super system, subsystem, and environment are always operated with. Any object, item, process, phenomenon, theory and much more is a system. The system, in turn, consists of elements and acts as a holistic

entity. In order for the system to work in the right direction, the elements of each system are ordered and interconnected. The interactions of the elements can be multivariate, hidden and contradictory. It follows from this that systemic thinking is a type of thinking that has a holistic perception of objects and phenomena, taking into account connections between elements. In addition, any object exists in time, in the present, past, future, which makes it possible for systemic thinking to trace the development of the system, super system, and subsystem in all time periods. According to the author of the “theory of inventive problem solving” G. S. Altshuller [45], nine mental screens work simultaneously in systemic thinking. Such a multi-screen systemic style of thinking is necessary and should become the norm for a person involved in the creative process. A person with systemic thinking thinks globally, sees multiple connections and patterns, is capable of seeing reality from different angles and in different planes, and is free from stereotypes. Systemic thinking differs by independence and interdisciplinary. To see multiple, hidden, unknown, sometimes contradictory connections and patterns, you need to have interdisciplinary knowledge. In the process of creative activity, systemic thinking helps to understand the structure of any system and the world, set tasks correctly, find the right methods for solving, create something new, synthesise knowledge from different areas, correctly analyse information and make high-quality decisions. Such a necessary skill of systemic thinking is formed in the learning process.

Critical thinking. Psychologist Diane F. Halpern views critical thinking as the use of cognitive methods that are controllable, substantiated, and focused, increasing the likelihood of achieving the desired result. These methods are used in problem-solving, inference formulation, probabilistic assessment, and decision making, and require skills that are reasonable and effective for the specific situation and type of solvable problem [46]. This definition shows that critical thinking is a set of important skills.

Critical thinking is the thinking of the highest order and is distinguished by its independence, autonomy, self-sufficiency, argumentation, rationality, intellectual perseverance and courage. All these qualities are necessary for critical thinking because it is evaluative, analytical. Creative thinking is generative in nature and new ideas and solutions created in the creative process require interpretation, evaluation, and verification. To do this, a critically thinking person uses various types of mental operations: analysis, comparison, generalisation, attention, judgment, categorisation, and others. Critical thinking is complementary to creative thinking. It should be noted that a critically thinking person must also think creatively in order to infiltrate deeply into the essence of a problem and formulate it correctly, evaluate the idea and make the best decision. In the information age, the demand for the development of

critical thinking skills is growing so that a person can select and process the information he needs from a large array. One of the important components of critical thinking is the ability to reflect on thinking. A critical thinking person is concerned with the issue of self-improvement, so he/she strives for creative search, cognition, search for new information, new evidence, and verification of the validity of knowledge, which implies a scientific approach and arouses curiosity. A critical thinker is open to doubt, which not only does not hinder him but, on the contrary, contributes to an increase in the effectiveness of decisions. The need for critical thinking arises when there is no way to solve a complex, non-standard problem on the basis of already existing knowledge and skills. Non-standard tasks require non-standard, creative solutions that can be achieved using critical thinking skills. With the help of critical thinking, a problem, an idea, a solution is considered carefully and evaluated. Unlike intuitive thinking, there are many methods for developing critical thinking, which will take some time and desire.

Research Methods

The article is based on the material of theoretical research aimed at explaining the essence of connections in the studied types of thinking, to reveal the internal mechanism of creative thinking. The ultimate goal of the theoretical research is to determine the prerequisites to establish the trajectory of the development of creative thinking. The entire research process is presented in the form of a thought experiment, during which 14 types of thinking were investigated. Creative thinking is distinguished by its versatility, and each of the proposed 14 types of thinking reveals a separate facet of it.

In the course of the research, such general logical reasoning methods as analysis, synthesis, induction, analogy were applied. The use of the analysis method made it possible to determine the individual properties of each type of thinking, characterising them as a necessary skill for the development of creative thinking, and the synthesis method combined these individual properties into a single whole. Then there was a logical transition from private knowledge to general knowledge using the method of induction. The inference made about the connection of disparate skills into a whole made it possible to model the trajectory of creative thinking. Using the method of analogy, the knowledge about the features of the proposed thinking was obtained on the basis of what similarities they have with creative thinking.

From general scientific methods such methods as abstraction, generalisation and systemic approach were used. With abstraction, it became possible to separate the secondary properties and connections in the proposed types of

thinking from the essential properties and connections necessary for the development of creative thinking. The application of the method of scientific knowledge as generalisation made it possible to establish the general properties and relationships of creative thinking with other species, as well as highlight the main and essential features of creative thinking. With the help of the systemic approach, a theoretical model for the development of creative thinking was built.

Results and Discussion

Some of the scientists who studied the nature of creative process considered insight to be the driving force of creativity, others – cognitive processes, intelligence, personal qualities, and motivation. The connection between creativity and certain types of thinking separately is also considered.

In this study, the types of thinking that contribute to the development of creative thinking were identified.

If any creativity is a combination of various combined and not very compatible elements, on the border of which unique inventions are born, then creative thinking is also a combination of different types of thinking. In the studied types of thinking, we established the common characteristic features, such as flexibility of thinking, productivity, originality, creativity, going beyond the usual, and the features of each of them, which can be an impetus for the generation of a creative idea, solution. The model of creative thinking based on these features shows the process of creative thinking from taking an active life position to making a decision and this allowed a more detailed insight into the essence of the creative thought process. When building in a number of types of thinking, the principle of level transition was adopted as a basis.

As a result of the integrated and systematic approaches to the study of the process of creative thinking, a list of prerequisites, which determine the trajectory of creative thinking, is proposed.

Creative thinking model based on prerequisites

Prerequisite	The essence of the prerequisite
Positive thinking	Taking an active life position
Synergistic thinking	Evolution and self-organisation, the ability to expand your vision of the world
Associative thinking	The ability to associate
Abstract thinking	The ability to abstract
Visual thinking	The ability to visualise the image of an object or situation through imagination

Prerequisite	The essence of the prerequisite
Algorithmic thinking	Step-by-step structuring of mental operations in order to determine the trajectories of the creative process
Divergent thinking	The ability to think in different directions based on the original problem
Lateral thinking	Approach to solving the problem from different positions
Janusian thinking	The ability to combine, consider opposites
Questioning style of thinking	The ability to ask the right questions that help to find and generate new ideas and solutions
Combinatorial thinking	The ability to make unique combinations
Intuitive thinking	The ability at an unconscious level to receive, process, assimilate and apply information
Systemic thinking	The ability to understand the structure of any system, see connections and patterns, think globally
Critical thinking	The ability to carefully select, process, ponder, evaluate a problem, information, idea, solution based on arguments

Creative thinking is multifaceted and each of the studied types of thinking reveals its certain facet, thereby demonstrating the need to include them in a single model of creative thinking and to show an integrated approach to its development.

The selected types of thinking have such skills as analysis, synthesis, selective comparison, generalisation of information, abstraction, association, combination, the ability to ask right questions, the ability to visualise, systemic vision, the assessment of ideas, the ability to draw conclusions, without which the development of creative thinking is impossible.

It follows from the above that the studies of the previous authors are of undoubted value in terms of a deep, comprehensive analysis of individual types of thinking. However, the range of the studied issue in them is limited within the limits of a specific, separately taken category of thinking which is quite natural for such works, while at this stage the task is to train specialists with a set of skills for creative thinking, capable of showing rapidity, flexibility and original-

ity in solving complex and extraordinary problems of the modern, dynamically changing world.

The importance of the present research lies in the systematisation and generalisation of the results of detailed examination of publications by other researchers and in the proposed model of creative thinking consisting of prerequisites. At the same time, a prerequisite is understood as a set of skills necessary for the successful development of creative thinking. In the presented model of prerequisites, the trajectory of mental activity is built and the connection of creative thinking with positive, synergetic, associative, abstract, visual, algorithmic, divergent, lateral, Janusian, questioning, combinatorial, intuitive, systemic, critical thinking is established. In particular, among the prerequisites, we rank positive thinking in first place, since a positive attitude is preferable and most important for starting the process of creative thinking. The list of prerequisites is completed by systemic and critical thinking, suggesting a thorough, summarising approach for making the final, most correct decision as a result of creative thinking activity.

In general, it should be emphasised that the proposed number of prerequisites has certain flexibility and variability depending on the nature of the problem being solved and this concerns mainly the intermediate links of this trajectory.

The programme of this study was limited to the study of issues of systematisation, generalisation and establishment of connections between creative thinking and other types of thinking. The study in this volume is completed by building a model of prerequisites.

The theoretical novelty of this research consists in identifying the characteristics of the types of thinking listed in the prerequisites, which are the preconditions for the successful development of creative thinking.

The application of the results of the first stage, the identification of empirical data and the demonstration of the dynamics of the development of creative thinking in students is the task of further research.

Conclusion

Nowadays, for the original solution of complex, non-standard problems, for the creation and implementation of new products and technologies necessary for society, a person is required to use creative thinking, which is the synthesis of non-traditional types of thinking.

The proposed approach to the formation of creative thinking contributes to the development such components as biological (*temperament – introvert, extrovert*), personal (*confidence, courage, determination, persistence, tolerance*),

existential (*internal maturity, independence of thinking, openness to innovation, non-conformism*), motivational (*desire, interest, self-actualisation*), cognitive (*perception, attention, memory, imagination, speech*), competence (*knowledge, experience, broad outlook*), communicative (*sociability, friendliness*), and emotional parts (*stress resistance, emotional sensitivity, empathy*). All of these components are integral to creative thinking.

The main results of the study regarding the proposed idea of prerequisites for creative thinking are the following provisions:

- determination of prerequisites for determining the trajectory of the development of creative thinking,
- establishing links between different types of thinking with creative thinking,
- types of mental operations for the development of each prerequisite are determined, and
- creating a model for the development of creative thinking.

It must be noted that the model of creative thinking activity based on the prerequisites can contribute to the development of new effective methods based on the principles of problematic, dialogical, constructive, synergetic, heuristic learning to develop creative thinking in students.

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Е. И. Snopkova – provided a literature review, and performed data analysis.

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