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A METHOD OF FORMING THE STUDENTS' CREATIVE TECHNICAL POTENTIAL AND ASSESSING THE LEVEL OF ITS FORMATION IN THE PROCESS OF IMPLEMENTING THE CONTENT OF TECHNOLOGICAL EDUCATION IN GYMNASIUM.

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The article substantiates the importance of forming the students' creative technical potential in the process of implementing the content of technological education in the gymnasium. According to the results of the analysis of literary sources, the essence and structure of the creative potential of an individual have been determined as a set of creative abilities contributing to the creation of socially significant original products. *For the first time*, the concept of "creative technical potential of gymnasium students" was introduced, which is defined, accordingly, as a set of creative technical abilities formed in gymnasium students. According to the results of a long experiment, methodical work with teachers, etc. the most important creative technical abilities of students have been determined that provide them with effective creative activity in the field of engineering and technology: technical thinking, technical creative imagination, associative thinking (different types of associations, associative connections), etc. It has been proven that certain creative technical abilities can be successfully developed in students in the process of designing and constructing technical objects (products), and thus form their creative technical potential. *For the first time*, a method of forming the students' creative technical potential and assessing the level of its formation has been developed in the process of implementing the content of technological education in the gymnasium (two interrelated methods). At the same time, the essence of the formation process is the development of the students' creative technical abilities, which correspond to the components of the structure of the individual's creative potential. The educational theoretical material necessary for the

successful formation of the students' creative technical potential has been determined. *For the first time*, the importance of mastering technology teachers with knowledge of the basics of the psychology of creativity has been substantiated and *the use of an integrative approach in the educational process of technology*.

Keywords: formation, creative technical potential, assessment, level of formation, content, creative abilities, technological education.

Problem setting. The new state standard of basic secondary education, model programs for grades 5–6, developed on its basis, emphasizes the importance of developing the students' creative abilities in the process of project-technological activity (the 1st direction of technological education "Implementation of an idea into a finished product according to an algorithm of project-technological activity"). According to these documents, one of the important types of educational activities of the 5th-6th grade students, which contributes to the development of their creative abilities, is the development of creative projects by students, the creation of products with elements of subjective novelty. In order to provide the technology teachers with methodical material on the basics of *designing and constructing of products*, methodically correct organization of the educational process in technology in the 5–6 grades of gymnasium etc. we have developed a methodology for implementing the content of technological education in gymnasium (Tarara, Sushko, 2021; Tarara, Sushko, 2022). At the same time, we note that the task of the adaptation period of training of 5–6 grade high school students should be the development of their *creative abilities* in the process of designing and constructing products of *considerable complexity*, mastering the necessary theoretical information on technologies etc.

In times of testing and a difficult situation in the country, the need for specialists with a high level of creative potential is especially growing, who would be able to: make non-standard creative decisions while rejecting generally accepted methods and means of solving new problems; solve problem situations successfully; generate extraordinary, original ideas, etc. Our country, now and in the future, needs creative professionals: creative engineers, constructors, designers, inventors, technologists who would participate actively in the development of new civil and military equipment, the maximum increase of the defense capability of our country as a whole. Therefore, in the 7th-9th grades of gymnasium, there should be a fundamentally different approach to implementing the content of technological education. Using the method of implementing the content of technological education in gymnasium, the knowledge and skills acquired by students during the adaptation period, the technology teacher should pay special attention to: the formation of the creative approach of students of grades 7–9 to solving urgent problems; development of various creative technical abilities; formation of initial knowledge, abilities and skills of rationalizing and inventive activity; creation by students of much more complex *products* (compared to those they created in 5–6 grades); the development of creative projects with *signs of novelty* (objective or subjective) etc., i.e. (as an integrated result of the above), to ensure the formation of the creative technical potential of gymnasium students (see the

next section of the article for necessary justifications, information on creative potential). At the same time, it is necessary to prepare the students of grades 8–9 to choose consciously the direction of specialized studies in a lyceum (grades 10–11 of a comprehensive school) (Tarara, 2020; Tarara, Sushko, 2019; Tarara, A.M., 2019). In the process of specialized training, it is necessary to ensure the further formation of students' creative technical potential, their choice of higher educational institutions of a technical direction, which is especially important for the country in the conditions of the war and post-war times.

In order to solve the given problem, teachers of technology should methodically correctly organize the educational process of implementing the content of technological education, which assumes that they have appropriate methodological developments and the necessary theoretical information.

Thus, the problem of forming creative technical potential in the students of grades 7–9 and developing the necessary methodological and theoretical-informational materials for this is urgent.

Analysis of recent research and publications. In order to fulfill successfully the given task, it is important for technology teachers to have a deep understanding of the essence of the creative technical potential of an individual, the components of its structure and content.

In general, potential means the ability to perform a certain action (physical potential, electrical potential etc.), a set of available means and opportunities in a certain field (military potential, economic potential etc.).

Many scientists paid attention to the problem of clarifying the essence of the concept of "creative potential of an individual".

As V.O. Moliako points out, in the simplest, shortest version, the creative potential of an individual should be understood as a resource, a measure of a person's ability to carry out creative activity. Creative potential is an integrative property of a person that characterizes his/her readiness and ability for creative self-realization and self-development (Moliako, 2004).

P.F. Kravchuk considers the creative potential as a set of opportunities for purposeful activity, which manifests the nature of the interconnection of all human abilities, his/her ability to go beyond the usual, already achieved (Kravchuk, 1993).

N.Y. Postaliuk considers the creative potential of an individual as a manifestation of various personality qualities and believes that a creative personality is defined not only by high creative potential, but also by the degree of activity in its realization (Postaliuk, 1989).

N.A. Karpenko defines the creative potential of an individual as a complex dynamic system…, the integral integrity of natural and social human forces, a set of abilities, opportunities for creative activity… (Karpenko, 2014).

Most scientists note that creative potential includes a number of individual abilities. In particular, V.V. Rybalko attributes to the components of creative potential: *intuition*, perseverance, purposefulness, making bold decisions, the ability to develop personal strategies and tactics while searching for ways out of difficult and non-standard situations, etc. (Rybalko, 1996). Y.O. Ponomarov singled out the following abilities: integrity of perception, *intuition*, fantasy, the gift of foresight, deviation from the pattern, originality, perseverance, high self-organization, etc. (Ponomarov, 1976).

I. I. Drach in his research defines the creative potential of a student's personality as a complex, personal-activity formation that contributes to the emergence of non-standard original solutions and has a number of components. In particular, as one of the components, the scientist singles out a set of the following creative abilities: imagination, memory, non-standard thinking, fantasy, intuition (Drach, 2005). We will not focus our attention on other components, since the problem of developing the creative potential of students, as future specialists in a specific field of production, and gymnasium students (grades 7–9 of a comprehensive school) has fundamental differences. The technology teacher of gymnasium does not need theoretical models of the organization of the educational process of the school (which is needed for the training of a specialist in a university), but practical methodical recommendations, a simple, clear and concrete method of forming the creative potential of students and evaluating the level of its formation in the scope of the content of the subject they study in gymnasium. We conducted research in the process of mastering the learning material of the subject "Technology" by students. At the same time, the main types of students' creative activity in technology lessons are designing, constructing and manufacture of products (State Standard, 2020). Similar considerations relate to the results of research on the problem of forming the creative potential of an individual in the higher education system and other scientists (Kravchuk, 1993).

V. O. Moliako notes that the creative potential of an individual becomes a real value only when it is realized in *inventions*, *constructions*, books, paintings etc. Focusing on his research and the research of other scientists, he developed *a general structure of creative potential*, which is determined by the following components (that is, *the creative abilities of an individual*):

1) drive *to create something new*, find and solve problems;

2) creative focus on searching for *analogies*, *combining*, reconstructing, changing options, economy in solutions;

3) *intuitionism* – the ability to manifest unconscious quick (sometimes instantaneous) assessments, forecasts, decisions;

4) the ability *to create associative arrays*;

5) tendencies towards constant comparisons, confrontings, development of benchmarks for subsequent comparisons, selection;

6) the ability to implement one's own strategies and tactics when solving various problems, tasks, finding a way out of complex, non-standard, extreme situations etc. (Moliako, 2006).

Taking into account the above, the following definition can be formulated: *creative potential is an integrated quality of a personality, which is a set of creative abilities that provide it with effective creative activity.*

At the same time, we define the concept of "creative technical potential of gymnasium students" as the integrated quality of gymnasium students, which is a formed set of their creative technical abilities.

Thus, based on the analysis of the latest research and publication, we can draw the following conclusions: for the successful formation of the creative technical potential of

students of grades 7–9 in the process of implementing the content of technological education in gymnasium, *the teacher should focus his/her attention on the development of the most important creative abilities in students*,, which are the components of the structure of individual's creative potential; the creative technical potential formed in students will be the basis for creative activity regardless of its direction (ensuring a certain degree of universality of students' creative activity); despite the presence of a significant number of scientific works devoted to the problem of creative potential, they lack information on the development of methods for the formation of creative technical potential in elementary school students, and even more so – the determination (assessment) of the level of its formation in students.

Formation of article goals. The purpose of the article is the scientific substantiation and development of the method of forming students' creative technical potential and assessing the level of its formation in the process of implementing the content of technological education in gymnasium.

Presentation of the main material. The problem of forming the creative technical potential of students of grades 7–9 of a gymnasium (grades 7–9 of a comprehensive school) was posed and solved by us for a long time in the process of experimental testing of educational materials developed by employees of the Technological Education Department of the Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine in the basic schools of the Department.

The study of the educational process in technology, the results of the experiment show that some teachers at the beginning of the experiment started their activities with the problem of forming the students' creative potential with insufficient confidence. This is explained by the fact that gymnasium teachers have a primitive idea about the essence of the individual's creative potential and methods, approaches, in general – methods of forming creative technical potential, and even more so – assessing the level of its formation in the students of 7–9 grades.

Therefore, the task of our research was to create an informational and methodological basis for teachers, which would include the following components: directly the method of forming students' creative technical potential and assessing the level of its formation (hereinafter – the method for short) in the process of implementing the content of technological education in gymnasium; theoretical educational material that reveals the essence of those creative abilities that must be developed in students for the effective formation of creative technical potential; methodical advice to technology teachers regarding the use of theoretical information in the educational process of technology.

The method of forming students' creative technical potential and assessing the level of its formation in the process of implementing the content of technological education in gymnasium.

The creative potential of an individual, as stated in the subsection of the article "Analysis of recent research and publications", is an integrated quality of an individual. Creative potential is a set of creative abilities that provide his/her with creative activity at a high level. A successful solution to the problem of formation of creative potential requires tech-

nology teachers to have the appropriate teaching methods. The teacher must methodically correctly organize the creative activity of students, ensure their successful performance of creative actions and operations of *designing, constructing and manufacture of products*, development of creative projects, as the main components of the content of technological education in gymnasium. The importance of the development of students' creative abilities in the process of performing the specified types of creative activities is especially emphasized in the new state standard of basic secondary education (State Standard, 2020). Therefore, in order to develop the methodology, it was necessary to determine, first of all, the most important creative abilities of students, which will meet the following requirements:

- the teacher will be able to successfully develop them in students in the process of designing, construction and manufacturing products;
- they are decisive for the creative activity of students (in particular, designing and constructing products of various levels of complexity);
- they are integrated (at least some of them), which ensures: the students' ability, inclination to successful creative activity at a high level; the concentrated activity of the teacher regarding the development and assessment of students' creative abilities and our experimental one (this condition is quite important – it allows us to determine for research only a small number of the most important creative abilities of students, since the *use of a significant number in the specified context is associated with significant difficulties*).

As shown by the results of a long-term experiment and methodical work with teachers, the analysis of the creative activity of creative engineers and inventors, the following creative abilities meet the specified requirements to the process of creating technical objects by specialists: *associative thinking (associations), technical creative imagination, technical thinking, skillful use of intuition by students in their creative activity*. In the context of the above, we will make some clarifications, remarks, and conclusions that will be necessary in the further presentation of the article's materials. In particular, technical thinking is also an integrated education, which includes a set of important student qualities that ensure successful creative activity (see below for detailed information on technical thinking). Practice shows that it is advisable to develop students' technical thinking during several stages during the designing and constructing of products of various complexity. Technical thinking is especially effective in close interaction with technical creative imagination (see below for detailed information on it as well), which led to their selection for research. The author of the article proved that the successful implementation of the processes of designing and constructing products is facilitated by the skillful use by students of their natural gifts, in particular, intuition (Tarara, 2022). The teacher should also take these skills into account when assessing their level of creative technical potential. At the same time, the following should be noted: *the teacher should teach the students to skillfully use this gift of nature in their creative activity of creating products, but the very question of developing students' intuition is not correct* (Tarara, 2022). Since concepts such as associations, creative imagination, intuition, and thinking belong to the categories of the psychology of creativity, it is important for technology teachers *to acquire knowledge of the basics of the psychology of creativity and, accordingly, to use an integrative approach* in the education-

al process of technologies (for a detailed justification of the importance of the above, see in the process of presentation of the material of the article).

*Taking into account the above, we will consider the methodically correct activity of the teacher i*n the context of the development of the determined creative abilities of students and their essence and place in the process of designing and constructing products. First of all, we note that the teacher must select products carefully (technical objects) for students to create.

This is a very important moment in the creative process. Products, their construction, structural components (assemblies, details etc.) must be such that the designing and constructing of which by students involves the development of their creative abilities – *components of the structure of creative technical potential*. In the event that students independently choose the products to create, the teacher provides them with appropriate advice. Next, the teacher should skillfully start the direct development of students' creative abilities.

In particular, teachers *should know* that the development of students' *associative thinking (associations) and technical creative imagination* ensures students' performance of creative actions and product design operations. This is explained by the fact that in the process of forming an idea, imaginary image of the future product, determining its general appearance, shape, structural elements etc. *associative thinking* is especially important, *the use by students of various types of associative connections (associations)* with known natural and man-made objects: birds, fish, plants (for example, with burdock), various technical objects or components of their construction (Tarara, 2022). From the various types of technical structures, images, concepts that arose in the student by association, he/she must select the one that best corresponds to the idea, the technical task he/she has created. Creation of an ideal, imaginary image of a technical object (product), development of several options for the design of the product, arrangement of individual components (nodes) of its structure, establishment of functional connections between them, expedient "transfer" of the obtained associative images to the technical object developed by students the object will be able to provide only his/her creative technical imagination also during the designing of the product. However, it should be noted that quite often the considered creative abilities (*associative thinking and technical creative imagination)* "work" in a complex, ensuring a high level of execution of all product design operations. In particular, *association by similarity* (as one of its types) plays an important role not only in the mental creation of images, but also in their imagined application in various situations. As you can see, the considered creative abilities are decisive, first of all, at the initial stage of product design.

In the process of research and subsequent design of the product, students must: to develop (in the form of a preliminary sketch, "sketches" or technical drawing) several options for the design of the future product in accordance with the formulated ideas, plan; to select interesting existing samples or products close to it from literary sources, everyday life and make the necessary constructive changes to them; to perform an analysis of the available design options of the product and choose the best one from them, or to create an optimal, sketch design option based on several existing ones (a sketch project – it gives

an opportunity to imagine the general design of the product), applying *the combination method* consciously. Thanks to the considered creative activity of the students, at this stage of the product design process, not only the creative abilities mentioned above (*associative thinking and technical creative imagination*), but also *technical thinking* are intensively developed. The development of technical thinking is even more intensive during the students' performance of product design operations and the creation of its manufacturing technology. Therefore, the *teacher should teach* students: to develop the final design of the product (in graphic form) based on a sketch version – a sketch project; to justify the choice of the necessary materials for the manufacture of the product and forecast their costs; to develop the necessary sketches and blueprints for individual parts and components of the product, as the basis of the product design process; to imagine and develop the technological process of manufacturing the product as a whole; to plan the technological sequence of manufacturing individual parts of the product. Since students use graphic images in the creative operations discussed above, the teacher in classes should pay attention to the formation of students' knowledge and skills from the basics of graphic literacy, which *will contribute to the further development of their technical thinking.*

It is especially important for the teacher to choose more complex products for students to create. During the design and construction of these products, students' *technical thinking* ensures their successful performance of the following creative operations: searching for analogies to the product being created; combination and reconstruction; comparing the new product with already known ones; finding a way out of a difficult situation by solving the identified contradiction in the technical design of the product; carry out calculations of the cost of the future product and its environmental examination etc. Such creative activity contributes to the development of the students' corresponding creative abilities, the desire to create something new, search for and solve important problems, students' drawing up of personal creative plans (strategies) and their implementation etc. (see the correspondence of the specified component of the structure of the creative potential of V. O. Moliako, taking into account the above considerations). At the same time, the technical thinking of students continues to develop intensively, *as an integrated set of the creative qualities of the individual*.

Thus, the methodically correct approach of the teacher to the organization of the creative process of designing and constructing products, the development of creative projects will ensure the effective development of *the most important creative abilities* in students *and, accordingly, the formation of their creative technical potential*. The development of the above-defined creative abilities in gymnasium students and its continuation in grades 10–11 will be the basis for training creative engineers, inventors and other creative specialists. *The importance of the mentioned for the country in the post-war period* is especially emphasized in the subsection of the article "Statement of the problem". As can be seen from the above, in order to ensure the successful implementation of the content of technological education in gymnasium, the creation of products by students at a high level, it is important for technology teachers to *master knowledge of the basics of the psychology of creativity and, accordingly, to use an integrative approach in the educational process*

(integration of content from the basics of technologies with content from the basics of the psychology of creativity).

Now let us turn to the consideration of the problem of assessing the level of formation of students' creative technical potential. Based on the above, it can be concluded that the components and structure of the creative potential of V. O. Moliako are especially important for the educational process in technology. As can be seen from the subsection of the article "Presentation of the main material", the creative abilities that develop in students in the process of designing, constructing and manufacturing products are components of the structure of the creative potential of V. O. Moliako's personality or correspond to them in their essence. The specified correspondence and the very fact of the presence of such components in the structure of creative potential are the basis for the development of a *methodology of evaluating* the level of formation of the creative technical potential of gymnasium students. Namely: the level of potential formation is evaluated based on the results of the evaluation of the level of *development of the most important creative abilities in students and is an integrated result*. We consider the above considerations and results of the experiment *as a scientific basis for the development of the methodology*, and in the general title (see the title of the article) two methodologies should be understood – formation and evaluation, between which there is, of course, a close connection.

Let's consider the essence of the methodology of assessing the level of formation of students' creative technical potential, using the scientific basis defined above. The teacher carefully monitors the students' performance of all creative actions and design and construction operations from the idea to its realization in the finished product and evaluates the level of development of the most important creative abilities of the students (*associative thinking (associations), technical creative imagination, technical thinking, students' ability to use their subconscious thinking – intuition*). We offer teachers two methods of assessment (of their choice). According to the first method, teachers should use our proposed *scale for evaluating* the level of development of project-technological competence, development of the *students' creative technical abilities: low, average, sufficient, high*. The use of these levels is legitimate because their content reflects all creative actions and operations of designing and constructing products corresponding to each value of the scale (Tarara, 2008; Tarara, 2014). Determining the level of development of a certain creative ability of a student based on its content does not cause any particular difficulties, but it is connected with the need to use additional materials (level content). The second method of assessing (determining) the level of formation involves the use by teachers of the same rating scale (*low, average, sufficient, high*), but the content of the levels is not necessary. According to this method, the teacher pays special attention to an important regularity: each of the students' creative abilities identified for research makes its "specific contribution" to the total level of students' creative technical potential. If, for example, one of them is not sufficiently developed, then its total level will be lower. It is not difficult for the teacher to find out which creative ability of the student is less developed in the process of designing, construction and manufacturing the product. After all, if a certain creative action or operation to create a product will be performed at a low level (and its effective

performance is ensured by the appropriate creative ability of the student, which was discussed in detail above), then the corresponding element of the structure of the technical object (or the entire object) will also be created at a low level. On the basis of such correspondence, the teacher draws a conclusion about the insufficient development of this creative ability and evaluates it at a certain level, for example, low or average. The latter, of course, affects the overall level of the student's creative and technical potential. In the future, the teacher pays more attention to its development and, accordingly, to increasing the overall level of creative technical potential.

Analyzing and summarizing the obtained results, the teacher determines the level of formation of the student's creative technical potential as an integrated result of the levels of development of his/her creative abilities that took place in the process of creating the product. Of course, the determined level of creative technical potential, as well as individual creative abilities, will correspond to one of the values of the above scale: low, average, sufficient, high. However, in order to develop students' interest in the results of the assessment of creative technical potential, to give them a familiar, more attractive look for them, we (and therefore teachers) can use a 12-point rating scale and accept that a high value of a student's creative technical potential corresponds to 12 points. Then: a sufficient value will correspond to 10 points, an average – 8, a low – 6 (and not a rating in the form of "low" or "high"). Since (according to the accepted scientific basis) the formed level of creative technical potential will correspond to the total result of the development levels of the three most important creative abilities (integrated result), then, for example, the maximum value of creative technical potential will be equal to 36 points (12+12+12 points, not the sum of three words "high").

Assessing students' ability to use their subconscious thinking (intuition) is associated with some difficulties. The results of the experiment show that these skills among students are quite different (including barely noticeable), which is explained by the different level of general development of the students in the class, their success in mastering science and mathematics disciplines, etc. Therefore, the teacher will be able to evaluate these skills only together with a specific student and even with his/her help (Tarara, 2022). It is also advisable to take these skills into account during the final determination of the level of formation of students' creative technical potential, since the ability to *intuitiveness* is a rather important quality of a person for successful creative activity (see the structure of creative potential by V.O Moliako). However, taking into account the above, we advise teachers to assess the ability to use the intuition in their creative activities only by students of the 9th grade, and then on the condition that they have at least a sufficient level of development. The students of the 7–8th grades only need to be prepared for this. Teachers will be able to use a 12-point scale to assess these skills. We emphasize that in the 1st evaluation method, teachers should also use the considered evaluation scale.

After making the product designed and constructed by the student, it is advisable for the teacher to evaluate it as the second, final stage. According to the results of the evaluation of the level of perfection of the product as a whole, its nodes, parts, functional connections, etc. the teacher determines the level of development of each of the students'

creative abilities (they ensure the high-quality creation of the product both as a whole and each component of its structure) and, accordingly, the final level of formation of the students' creative technical potential.

The effectiveness of the method developed by us for the formation of students' creative technical potential and assessment of the level of its formation in the process of implementing the content of technological education in gymnasium has been confirmed by the results of the long-term experimental testing of the content of the educational materials, which has already been mentioned above.

In addition to the considered teaching methodology, to ensure the effectiveness of their educational activities, teachers should master the relevant theoretical material on the considered problem. Therefore, the next task of our research was to determine the theoretical educational material that reveals the essence and content of each of the identified creative abilities, and to provide teachers with methodological advice on its use. *In the presence of scientific works published by us on the research problem, we will make appropriate references to them*, since the limitations of the article do not allow us to consider all issues in detail.

Educational theoretical material and methodological recommendations for teachers regarding its use. It is quite important for teachers to have a deep understanding of the essence and content of those creative abilities that are supposed to be developed in students in the process of implementing the content of technological education in gymnasium and, accordingly, to form their creative technical potential. Let's start with the most informative – technical thinking.

Technical thinking.

The concept of "technical thinking" is one of the most important concepts of technical creativity, which is closely related to a number of other concepts: "creativity", "creative potential", "technical creative activity", "thinking", "creative thinking", "technical creative imagination", "technical creativity", "design", "construction" etc.

Thinking is a special type of human activity, "vision" in thought, resulting in objective reality or subjective knowledge, or an ideal image. Creative thinking is characterized by the ability to think critically. The teacher should know that the presence of critical thinking in students allows them to give answers to alternative questions, name the reasons for an alternative choice, imagine a certain situation, name its positive and negative aspects. The teacher should remember that the student thinks creatively if there is independence in his/her work, which involves establishing cause and effect relationships without the teacher's help.

For a technology teacher, the question of the place, role and significance of technical thinking in the technical creativity of students is quite important. Students should clearly understand that technical thinking is aimed at learning about technical, technological phenomena and processes, essential connections between them. Technical thinking is characterized by such qualities as: the urge to create something new, finding and solving technical problems, the ability to compare, flexibility, independence, originality, and activity when solving special tasks (Kudriavtsev, 1976). A person with developed technical thinking possesses a system of generalized knowledge and skills, understands the technical

interrelationships of structures, functions of individual parts. Technically minded students can easily read blueprints, determining the number of parts that will make up the product.

An important form of manifestation of technical thinking is the ability to analyze technical objects in kind or according to technical drawings and diagrams, to divide them into parts, to determine the functions and purposes of each of them, to *mentally connect* the work of individual parts into a single whole, to compare them, to identify common and excellent in technical objects and processes, to classify and generalize them, etc.

The development of the students' technical thinking must be carried out in the process of practical creative activity.

The teacher must form the following aspects of technical thinking in students:

1. Ability to plan. Planning is the first and very important stage in the development of technical thinking.

2. The ability to find compromise solutions, in particular, the student's search and acceptance of a decision that would satisfy the optimal version of the product design.

3. The ability to think "flexibly". This quality includes the student's readiness to consider new options in order to create a new one, to change point of view with appropriate justification. Flexibility of thinking allows a person to propose methods of solving the problem that are significantly different from those previously proposed.

4. Solving problems by students: related to the knowledge of technology and technological processes, which are as close as possible to real production; with technical content, in which it is necessary to find a technical contradiction and solve it in a certain way, etc. It is important in this context to acquaint students with techniques for resolving technical disputes. *The teacher should also take into account* that in the process of forming the students' creative technical thinking, science fiction plays an important role.

The teacher should know that there are a number of factors that hinder the creative process, the development of creative thinking. Let's consider them.

1. Reasons united under the common name of *conformity*. These are such human traits and actions as pliability, imitation, easy suggestibility, desire to be like others, lack of independence.

2. Trying to find a solution quickly to a certain task, problem, which often leads to ill-considered decisions.

3. Lack of critical thinking and carefully check the result. A creative person should have a reasonable combination of creative and critical thinking.

4. Tendency to overestimate the obtained results while simultaneously denying other ways of completing the task.

Thus, the problem of developing the students' technical thinking was and remains quite important. It should be considered by the teacher as a way to activate the students' educational activity, an effective tool that will make the learning process interesting and attractive.

In more detail and with some other aspects of technical thinking, the teacher may get acquainted from scientific literature, in particular, in our publications (Tarara, 2014).

Technical creative imagination.

First, let's dwell briefly on the concepts of "imagination" and "creative imagination". *The teacher should remember well* that the creation of new imaginary subjects in students occurs during his/her story, presentation of a new material, independent processing of certain educational information, etc. Imagination in a person is generated, first of all, by the need to change certain objects of the surrounding world or to create new ones. Spaceships, hydroelectric stations, modern cars, etc., would not have been created without imagination, dreams and creative ideas. Thanks to imagination, we can mentally go beyond what we perceive directly, it helps to predict the future. *The teacher should offer students* several definitions of the term "imagination": "Imagination is a person's representation of a certain object in the absence of the real object itself", "Imagination is the process of a person creating images of objects that he/she has never perceived." Creative imagination is the basis of many types of creative activity, which is characterized by the novelty of the resulting product. Creative imagination "draws" new, original images and ideas. *Together with technical thinking, it forms the basis of the students' technical creativity.* Based on the above, the following definition of creative imagination can be formulated: "Creative imagination is a type of imagination during which a person independently creates new images and ideas that represent a certain value." Ideas can be embodied in specific products of creative activity.

Technical creative imagination. The creation of new technical objects, technologies, etc., is a synthesis of individual elements of previous human experience. *In the subconscious of a person* there were only separate elements of that new technical object that must be created. *Thanks to technical creative imagination, these elements are combined into the desired imaginary image of the technical object being created.* Such formations are called imaginary images. Having informed students of the above information in a simplified form accessible to them, the teacher gives students the necessary definition. Technical creative imagination is such an activity of the human brain, in the process of which new, original technical ideas and images are purposefully created on the basis of accumulated experience, the practical implementation of which has social value.

For the development of technical creative imagination (in addition to the one already considered in the article above), the teacher needs to solve tasks with students to: increase the features inherent in the subject; reduction of features characteristic for the subject; representation of the actual dimensions of technical objects based on their graphic representation; representation of the actual dimensions of technical objects based on their verbal description; image of the subject according to its description; description of the object according to its image; joining an element from another subject to a subject; replacement of an element in the subject with an element taken from another subject; a graphic representation of a detail or node hidden in the drawing etc.

Associative thinking (associations). Intuition.

Educational information about associative thinking (associations) and intuition is detailed in our scientific work (article): "Intuition and associations in the process of teaching students to design and construct technical objects. Innovative scientific research in the field of pedagogy and psychology: materials of the International scientific and practical conference, Zaporizhzhia, February 11–12, 2022. P. 43–46" (Tarara, 2022).

The specified scientific work can be found in the electronic library of the National Academy of Educational Sciences of Ukraine at the link: https://lib.iitta.gov.ua/730289/1/Teza_Tarara_2022.pdf

You can also get acquainted with it in the Technological Education Department of the Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine.

Conclusions. 1. Based on the results of the analysis of the educational process in technology in gymnasium, the situation in the country at the moment and according to future forecasts, a conclusion has been made regarding the need to form the students' creative technical potential in the process of implementing the content of technological education in gymnasium.

2. Technology teachers are offered a concise definition of the creative potential of an individual, its essence has been clarified, the question of the components of the structure of creative potential as a set of creative abilities of students has been considered.

3. Based on the results of the analysis of the components of the structure of the creative potential of the individual, the students' creative activity in the process of designing and constructing products, a conclusion has been made regarding the feasibility of using the structure of creative potential according to V. O. Moliako in the educational process of mastering the technologies by students.

4. Based on the analysis of the results of the experimental testing of educational materials developed by the employees of the Technological Education Department of the Institute of Pedagogy of the National Academy of Educational Sciences of Ukraine, methodical work with technology teachers, analysis of their conclusions, etc., the most important creative abilities of students, which are necessary for them to perform effectively the processes of designing and constructing products have been determined: technical thinking, technical creative imagination, associative thinking (associations). The importance of teaching students to use intuition skillfully in creative activities has been also emphasized.

5. For the first time, a method of forming creative technical potential and assessing the level of its formation has been developed in the process of implementing the content of technological education in gymnasium.

6. The theoretical educational material has been defined, which reveals the essence of the most important creative abilities, as components of the structure of the students' creative technical potential.

7. For the first time, the importance of mastering knowledge of the basics of the psychology of creativity by technology teachers has been substantiated and, accordingly, the use of an integrative approach in the initial process (integration of content from the basics of technology with content from the basics of the psychology of creativity).

Література

Tarara, A., Sushko, I. (2021). Features of development of scientific and methodological support for implementation of technological education content in the gymnasium (primary school). Проблеми сучасного підручника. 26. 226–261. http://ipvid.org.ua/vypusk-26/Statti_2021_26/Anatoliy%20Tarara.pdf

Tarara, A., Sushko, I. (2022). Methods of implementing the content of technological education in the gymnasium. Проблеми сучасного підручника. 28. 177–191. http://lib.iitta.gov.ua/731695/2/%D0%A1%D1%82%D0%B0%D1%82%D1%82%D1%8F%20%D0%9F%D0%A1%D0%9F%202022%20%28%D0%BF%D0%B5%D1%80%D0%B5%D0%BA%D0%BB%D0%B0%D0%B4%29.pdf

Tarara, A. (2020). Scientific and methodical provision of profile technologies training in high school. Проблеми сучасного підручника. 24. 256–269.

http://lib.iitta.gov.ua/721259/1/Anatolii%20Tarara.pdf

Tarara, A., Sushko, I. (2019). Educational guide of special course for professional education of technologies of engineering and technical direction: peculiarities of designing and implementation of contents. Проблеми сучасного підручника. 22. 274–289.

Тарара, А.М. (2019). Проєктування іконструювання об'єктів техніки: Навчальний посібник. Київ: КОНВІ ПРІНТ. https://lib.iitta.gov.ua/723046/1/%D0%BF%D0%BE%D1%81%D1%96%D0%B1%D0%BD%D0%B8%D0%BA_12_2019.pdf

Моляко, В. (2004). Психологічна теорія творчості. 6. 2–9.

Кравчук, П.Ф. (1993). Формирование творческого потенциала личности всистеме вищего образования: Автореф. дис…докт. филос. наук: 22.00.06. Москва.

Посталюк, Н.Ю. (1989). Творческий стиль деятельности. Педагогический аспект. Казань.

Карпенко, Н. (2014) Психологічний зміст іструктура творчого потенціалу особистості. Науковий вісник.1. 190–201.

Рибалко, В.В. (1996). Психологія розвитку творчої особистості: Навчальний посібник. Київ: ІЗМН.

Пономарьов, Я.А. (1976). Психология творчества ипедагогика. Москва: Педагогіка.

Драч, І.І. (2005). Організація навчального процесу зрозвитку творчого потенціалу студентів вищих навчальних закладів I – II рівнів акредитації.: Дис… канд. пед. Наук: 13.00.01. Київ.

Державний стандарт базової середньої освіти (2020). Постанова КМУ №898 від 30.09.2020 року. https://osvita.ua/legislation/Ser_osv/76886

Моляко, В.О. (2006). Здібності, творчість, обдарованість: теорія, методика, результати досліджень. Житомир: Рута.

Тарара, А. (2022). Інтуїція іасоціації упроцесі навчання учнів проєктуванню іконструюванню технічних об'єктів. Інноваційні наукові дослідження вгалузі педагогіки іпсихології: матеріали Міжнародної науково – практичної конференції. С.43–46. https://lib.iitta.gov.ua/730289/1/Teza_Tarara_2022.pdf

Тарара, А.М. (2008). Розвиток творчих здібностей учнів 5–9-х класів упроцесі проєктно-технологічної діяльності. Методичний посібник.

Тарара, А.М. (2014). Технічна творчість учнів основної школи упроцесі проєктної ітехнологічної діяльності: Навчально – методичний посібник.

https://lib.iitta.gov.ua/712178/1/14-05.pdf;

Кудрявцев, Т.В. (1976). Психология технического мишления. Москва: Просвещение.

References:

Tarara, A., Sushko, I. (2021). Features of development of scientific and methodological support for implementation of technological education content in the gymnasium (primary school). Problemy

suchasnoho pidruchnyka. 26. 226–261. http://ipvid.org.ua/vypusk-26/Statti_2021_26/Anatoliy%20Tarara.pdf

Tarara, A., Sushko, I. (2022). Methods of implementing the content of technological education in the gymnasium. Problemy suchasnoho pidruchnyka. 28. 177–191. http://lib.iitta.gov.ua/731695/2/%D0%A1%D1%82%D0%B0%D1%82%D1%82%D1%8F%20%D0%9F%D0%A1%D0%9F%202022%20%28%D0%BF%D0%B5%D1%80%D0%B5%D0%BA%D0%BB%D0%B0%D0%B4%29.pdf

Tarara, A. (2020). Scientific and methodical provision of profile technologies training in high school. Problemy suchasnoho pidruchnyka. 24. 256–269. http://lib.iitta.gov.ua/721259/1/Anatolii%20Tarara.pdf

Tarara, A., Sushko, I. (2019). Educational guide of special course for professional education of technologies of engineering and technical direction: peculiarities of designing and implementation of contents. Problemy suchasnoho pidruchnyka. 22. 274–289.

Tarara, A.M. (2019). Proyektuvannya ikonstruyuvannya ob'yektiv tekhniky: Navchal'nyy posibnyk. Kyyiv: KONVI PRINT. https://lib.iitta.gov.ua/723046/1/%D0%BF%D0%BE%D1%81%D1%96%D0%B1%D0%BD%D0%B8%D0%BA_12_2019.pdf

Molyako, V. (2004). Psykholohichna teoriya tvorchosti. 6. 2–9.

Kravchuk, P.F. (1993). Formirovaniye tvorcheskogo potentsiala lichnosti v sisteme vishchego obrazovaniya: Avtoref. dis…dokt. filos. nauk: 22.00.06. Moskva

Postalyuk, N.YU. (1989). Tvorcheskiy stil' deyatel'nosti. Pedagogicheskiy aspekt. Kazan'.

Karpenko, N. (2014) Psykholohichnyy zmist istruktura tvorchoho potentsialu osobystosti. Naukovyy visnyk.1. 190–201.

Rybalko, V.V. (1996). Psykholohiya rozvytku tvorchoyi osobystosti: Navchal'nyy posibnyk. Kyyiv: IZMN.

Ponomar'ov, YA.A. (1976). Psikhologiya tvorchestva ipedagogika. Moskva: Pedagogíka.

Drach, I.I. (2005). Orhanizatsiya navchal'noho protsesu z rozvytku tvorchoho potentsialu studentiv vyshchykh navchal'nykh zakladiv I–II rivniv akredytatsiyi.: Dys. kand. ped. Nauk: 13.00.01. Kyyiv.

Derzhavnyy standart bazovoyi seredn'oyi osvity (2020). Postanova KMU №898 vid 30.09.2020 roku. https://osvita.ua/legislation/Ser_osv/76886

Molyako, V.O. (2006). Zdibnosti, tvorchist', obdarovanist': teoriya, metodyka, rezul'taty doslidzhen'. Zhytomyr: Ruta.

Tarara, A. (2022). Intuyitsiya iasotsiatsiyi u protsesi navchannya uchniv proyektuvannyu ikonstruyuvannyu tekhnichnykh ob'yektiv. Innovatsiyni naukovi doslidzhennya v haluzi pedahohiky ipsykholohiyi: materialy Mizhnarodnoyi naukovo – praktychnoyi konferentsiyi. S. 43–46. https://lib.iitta.gov.ua/730289/1/Teza_Tarara_2022.pdf

Tarara, A.M. (2008). Rozvytok tvorchykh zdibnostey uchniv 5–9-kh klasiv u protsesi proyektno-tekhnolohichnoyi diyal'nosti. Metodychnyy posibnyk.

Tarara, A.M. (2014). Tekhnichna tvorchist' uchniv osnovnoyi shkoly u protsesi proyektnoyi itekhnolohichnoyi diyal'nosti: Navchal'no – metodychnyy posibnyk. https://lib.iitta.gov.ua/712178/1/14-05.pdf;

Kudryavtsev, T.V. (1976). Psikhologiya tekhnicheskogo mishleniya. Moskva: Prosveshcheniye.

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МЕТОДИКА ФОРМУВАННЯ ВУЧНІВ ТВОРЧОГО ТЕХНІЧНОГО ПОТЕНЦІАЛУ Й ОЦІНЮВАННЯ РІВНЯ ЙОГО СФОРМОВАНОСТІ УПРОЦЕСІ РЕАЛІЗАЦІЇ ЗМІСТУ ТЕХНОЛОГІЧНОЇ ОСВІТИ ВГІМНАЗІЇ

Встатті обгрунтовано особливості методики формування вучнів творчого технічного потенціалу упроцесі реалізації змісту технологічної освіти вгімназії. За результатами аналізу літературних джерел визначено сутність іструктуру творчого потенціалу особистості як сукупності творчих здібностей, що сприяють створенню нею суспільно значущих оригінальних продуктів. *Вперше* введено поняття «творчий технічний потенціал учнів гімназії», що визначено, відповідно, як сформовану вучнів гімназії сукупність творчих технічних здібностей. За результатами тривалого експерименту, методичної роботи звчителями іт.ін. визначено найбільш важливі творчі технічні здібності учнів, які забезпечують їм ефективну творчу діяльність вгалузі техніки ітехнологій: технічне мислення, технічна творча уява, асоціативне мислення (різного типу асоціації, асоціативні зв'язки) тощо. Доведено, що визначені творчі технічні здібності можна зуспіхом розвивати вучнів упроцесі проєктування й конструювання технічних об'єктів (виробів), аотже іформувати їхній творчий технічний потенціал. *Вперше розроблено методику* формування вучнів творчого технічного потенціалу й оцінювання рівня його сформованості упроцесі реалізації змісту технологічної освіти вгімназії (дві взаємопов'язані методики). При цьому, сутність процесу формування полягає урозвитку вучнів творчих технічних здібностей, які відповідають складовим структури творчого потенціалу особистості. Для розроблення методики оцінювання створено відповідну наукову основу. Визначено навчальний теоретичний матеріал, необхідний для успішного формування вучнів творчого технічного потенціалу. *Вперше* обгрунтовано важливість оволодіння вчителями технологій знаннями зоснов психології творчості і*використання внавчальному процесі зтехнологій інтегративного підходу*.

Ключові слова: формування, творчий технічний потенціал, оцінювання, рівень сформованості, зміст, творчі здібності, технологічна освіта.