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Pedagogical and Psychological Fundamentals of Developing the Spatial Imagination of Students in the Process of Teaching the Sciences of Engineering Graphics

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Annotation: This article shows the role of engineering graphics and its pedagogical and psychological foundations in the development of students' spatial imagination and thinking.

Key words: drawing geometry, drawing, psychology, pedagogy, positional problem, metrical problem, perception, fantasy, abstract, reproductive, productive, imagination, thinking, comparison.

Introduction

A future pedagogue should have knowledge, skills and qualifications in his field. In the books of pedagogy and psychology, the meaning and essence of these terms are revealed. For example, knowledge is a systematized set of scientific information about existence, reflected in the mind of a person in the form of concepts, schemes, certain images. Skill is a person's ability to organize a certain activity. Skill is an automated form of performing a specific action, activity[1]. Ensuring that future pedagogues have sufficient potential in their specialties should be paid attention to the level of state importance.

In his speech, the President of our country said that "… it is an important task to further develop not only academic science, but also science in higher educational institutions.[2]" The conclusion is that raising a young generation with the ability to be creative and think independently in higher education is always an urgent issue. Engineering graphics science has an important role in this.

A deeper analysis of the role of technology in human activity leads to the following two conclusions. First of all, the demands for the development of a person's ability to think figuratively, and the excitability of his spatial imagination are increasing. Secondly, the role of

[1] Inoyatov U., Muslimov N., Usmonboyeva M., Inog‘omova D. Pedagogika: 1000 savolga 1000 javob. -T.: “TDPU rizografi”. 2012.61- bet.

[2] Mirziyoyev Sh.M. Tanqidiy tahlil, qat’iy tartib-intizom va shaxsiy javobgarlik – har bir rahbar faoliyatining kundalik qoidasi bo‘lishi kerak. 2016 yildagi Vazirlar Mahkamasining 2016 yil yakunlari va 2017 yil istiqbollariga bag‘ishlangan majlisidagi nutqi. – T.: “O‘zbekiston”, 2017. 46-bet.

graphic tools in providing information about the spatial properties and relationships of the object and storing them is growing exponentially[3].

The development of spatial imagination and thinking is of great importance in mastering the knowledge of drawing by students. One of the important directions is for the student to master the methods of depicting spatial forms on a plane, and the second is to know the methods of determining the positional and metrical relationships between these forms. But these operations are performed through flat shapes. When determining the relationships between spatial forms, the spatial images of the operations related to making, i.e., their movements in space, should be embodied in the eyes of the student, that is, the student should imagine them in volume on the basis of flat shapes.

Concepts of spatial imagination and thinking, perception and imagination are psychological processes, so let's give some information from the science of psychology about the mental processes associated with them.

The following results are known from the experiments conducted by the Russian psychologist I.P. Pavlov:

if the analyzer is not affected by a single stimulus, but by a total of stimuli, then the resulting reaction depends on how each of the stimuli is connected and related to each other. That is, not depending on the characteristic of the trigger. I.P. Pavlov called this phenomenon *the attitude reflex.*

Relational reflex is a reflection of objective interdependence of certain properties of things. The study of anything or phenomenon begins with its perception. In the projective drawing section of the science of drawing, the rules of performing the views of models and details are studied. In this, the student learns to build projections on the plane of what he perceives. *"Perception is the reflection in the human mind of objective beings, objects and events that directly affect the sense organs"*[4].

Perception processes arise not only as a result of surrounding objects influencing our sense organs, but also as a result of the perceiving person's influence on objects in his material knowledge and practical activities.

Attention is very important in cognitive processes. Attention increases the activity of perception and serves to make perception perfect, accurate and clear.

Systematic and long-term voluntary perception of things and events related to a certain field is called *observation.* But for observation to be effective, it is necessary to have active thinking along with sufficiently strong, stable attention. When teaching the subject of "Design" in drawing, by showing the students how to design various details and items according to the given conditions, they perceive the item and understand the true essence of the topic.

Imagination, like perception, is an image of intuition. However, unlike perception, the image of things does not affect it now, but it has affected it at some point. An image is a secondary image of an object or event.

Imagination is derived from the Arabic word, which means *to think, to imagine, to visualize, to embody in the mind*. That is, first of all, *the information, knowledge, and understanding of a*

[3] Umronxo‘jayev A. Maktabda chizmachilik o‘qitishni takomillashtirish. –T.: “O‘qituvchi”, 1993. 7-bet.
[4] Ўзбек тилининг изоҳли луғати. «Ўзбекистон миллий энциклопедияси», 2 жилд, 2006-175 б.

person's imagination about things, events, etc. Secondly, *consciousness, imagination as the source of such information, understanding, knowledge formation*[5].

And when we say imagining, we mean re-imagining, embodying, perceiving. In philosophy and psychology, this term is understood as the reflection and embodiment of a perceived, felt thing or event in the mind of a person.

In psychology, imagination is divided into two main types: *memory imagination* (restoration of the image of previously perceived objects) and *fantasy images* - the formation of new images as a result of the transformation (reworking) of images stored in memory. Determining the solution to design issues through imagination is an interesting process for both the student and the teacher. Because the teacher announces the condition of the design problem and gives advice on how to approach its solution.

In the process of teaching drawing, the development of these two types of imagination in students is important. For example, the student imagines how appropriate to cut the detail he perceived before, how it will look after the cut, ensures the harmony of memory and imagination. Or, executing the visions of the detail that he designed in his imagination, making corrections to it, allows the images of his imagination to be reflected on paper.

The image of this or that thing is formed as a result of perceiving it many times. In this process, a sorting of signs in an object or event takes place, and the most characteristic feature of this object is preserved in memory. For example, a student needs to sort out the characteristic aspects and signs of objects in his perception in order to design a new detail or device based on the details and objects he perceives as a result of viewing, making views, observing various technical tools.

In the transition from perception to imagination, a certain simplification of sensory images occurs. For example, attention is paid to the fact that the design of the detail designed by the student meets the requirements, can identify the most appropriate option in terms of economy, cost and quality, and further improve it.

First of all, the most informative, basic elements of things, i.e. "bone" (base) are stored in the imagination. Such a "bone" is usually the shape of an object, or rather, the peculiarity of the shape. For example, we imagine that designing means inventing something new.

It seems that it is economical to store the image of the reflected object in such a simplified way in the brain's information base. But simplifying the image is related to leaving out a certain part of information, i.e. loss. That is why imagination cannot be like perception in its completeness.

According to E.V. Shorokhova's research, when a person performs a practical activity in relation to an object in the imagination, the signs of the object related to this practical activity remain. In particular, they have a clearer idea of which products or tools are used for their activities. That's why it's not enough to limit students to only showing what is needed to form this or that imagination. The demonstration must be accompanied by practical actions. So, no matter how much we talk about design issues, no matter how much we do not use designed objects, we cannot ensure that the student has full knowledge and skills. Therefore, we must assign them the task of completing a graphic task independently. Only then will they have a strong imagination of design and construction activities.

[5] Ўзбек тилининг изоҳли луғати. «Ўзбекистон миллий энциклопедияси», 4 жилд, 2008-7 б.

The word plays an important role *in abstracting and summarizing the spatial properties of things in the formation of imagination*.

In order to form a spatial image of things divided into parts, it is necessary to analyze them with words along with their practical actions, because in this process the mutual positional relations between the elements of the form of things are revealed.

Visualizing a thing through its image is also very useful. But the images are also different, for example, there is a big difference between a clear visual image of an object and its orthogonal projections (images), so such a situation requires a separate approach to each of them.

Perceiving real objects and describing them with words is the most effective way to form a spatial image. Nowadays, the use of modern information and communication technologies in lectures and practical training is becoming a tradition. Therefore, it is necessary to use it effectively in drawing lessons, especially in the teaching of "Designing". That is, showing the geometric operations or cutting, engraving, and finishing operations performed in the process of detail design in 3600 using *AutoCAD* and *3D max* programs and explaining it verbally greatly expands the student's imagination.

Imagination is the main building block of imagination. In essence, imagination is the re-transformation of imagination, that is, their mental division into parts, integration, transformation, etc.

In psychology, imagination is divided into two types: *regenerative* (or reproductive) and *creative* (productive).

In the first case, a person did not perceive the object before, but received information about it, a description, scheme, etc. Such images include, in particular, imaginations formed during the process of reading drawings and schemes.

In the process of *creative imagination*, new images are formed, their realization leads to the creation of new material and cultural assets (for example, the construction of a machine, literary images, etc.).

Imagination development is one of the most important conditions for a person's drawing and reading, as well as graphic work in general. At the same time, the process of teaching drawing is the most important tool in the development of imagination.

A decisive role in a person's activity is played by *free imagination*, that is, *goal-oriented free imagination of activity*.

According to the conducted studies, imagination develops in the process of teaching. One of the important tasks in this process is the formation of imagination methods in students. Drawing plays a big role here. If a student is given a detail and given the task of improving its design and reducing its weight, the goal-oriented process of free imagination begins.

In general, one of the important conditions for the development of spatial imagination is *practical activity*. However, the transition from practical actions to mental actions does not seem to happen automatically. In this case, the development of the imagination requires *the unity of action and words*.

Thinking plays an important role in solving practical and theoretical problems.

Thinking is the highest form of human activity. Thinking is a tool for knowing the surrounding world and is a prerequisite for the emergence of rational practical activity of a person.

Thinking in relation to sensations and perceptions, memory and imagination is of particular importance in people's knowledge and practical activities.

Tafakkur is derived from the Arabic word, which means *to think*. First, *it is understood as the process of active perception of objective reality in imagination, understanding and discussion, human thinking ability, thinking,* and secondly, *it is understood as thinking, reflection, discussion, thought*[6].

Thinking is a generalized reflection of reality.

The most important connections and relationships between things or events are revealed with the help of thinking.

Thinking is such a mental activity of a person that this activity allows to reflect (know) the reality in the most accurate (correct), complete, deep and generalized way, and allows a person to engage in more reasonable practical activities. For example, foresight allows us to set geometric, structural, design, and cost-effectiveness criteria and act accordingly.

Spatial thinking is also a type of mental activity, and in the process of solving practical and theoretical problems, it provides the construction of spatial images and the actions of spatial images with them. For example, we need to first imagine the item being designed, check it in our imagination, and design its image on paper. In this, the process of moving from space to a flat drawing and vice versa, from a flat drawing to space, and at this time the work of mental activity related to its improvement is carried out.

Imagination is the main mechanism of spatial thinking. Actions and re-exchanges with images constitute its main content. In spatial thinking, recoding is constantly taking place, that is, moving from real spatial objects to their conditional graphic representations, from three-dimensional images to two-dimensional images and vice versa. As an example, we can show that in order to develop a project of a model that passes through three given holes, it is necessary to take into account the creation of a model from the combination of three holes and geometric surfaces corresponding to it. After visualizing such a detail, the process of spatial thinking takes place through the activity of imagination.

Thinking happens in the form of mental actions. Comparison, analysis and synthesis, abstraction and generalization, concretization, classification and systematization are the main types of mental operations.

Comparison is a mental operation that is expressed in determining the similarity or difference between some things, the presence of equality and inequality, the presence of similarity or contrast.

Comparison is a process of thinking, and this process occurs when it is necessary to determine the similarity or difference of perceived things, or when it is necessary to find similarities and differences that are not directly reflected in sensations and perception. For example, when asked to improve an existing device, its differences and advantages can be understood by comparing its similarities, that is, the student should be given a comparison as a task.

The process of abstraction also occurs when comparing objects with each other. Certain aspects are always compared to each other, depending on the specific characteristics of objects or events (color, shape, speed of movement, etc.), they are compared to each other.

[6] Ўзбек тилининг изоҳли луғати. «Ўзбекистон миллий энциклопедияси», 4 жилд, 2008-7 б.

Thinking is divided *into concrete and abstract thinking*. If we perceive or imagine what is being thought about, this thought is a concrete thought.

Our discussions about the geometric shapes that we see in it are an example of such concrete thinking. Discussions about a curve, a surface that we can imagine can also be an example of concrete thinking.

This is thinking based directly on the images of things. This is obvious thinking.

Concrete thinking is also divided into two types: *object-obvious thinking* and *figurative-obvious thinking*.

Thinking in which the object of thought is directly perceived is called object-obvious thinking.

Our discussions about the geometric shapes that we see can be an example of such *objective-obvious thinking*.

During the lesson, when the student explains the structure of a complex surface and shows the students that it exists in detail, the thinking of the teacher and the student can be *figurative-clear thinking*. This type of thinking is mainly perceptual.

Object-oriented thinking is manifested not only in discussions, but also in direct actions. Such thinking is *object-action thinking*. In the teaching of the topic "Design", the process of both *objective-obvious thinking* and *objective-active thinking* is carried out. That is, an exhibition of dynamic models or details, which are being designed in several options, will be shown.

Thinking when we do not perceive what is being thought about, but only imagine it, is called *figurative thinking*. Such thinking relies on *memory or imagination*. For example, in the task of designing a model on the basis of the layout lines given to the student, the detail is created by clipping and cutting only on the clear image of the detail, and the detail is imagined and its orthogonal projections are performed through *figurative thinking*.

Every person directly perceives and imagines complex things (for example, machines, natural phenomena) and thinks concretely about them.

Abstract thinking is based on general and abstract concepts. This is a thinking consisting of concepts, this thinking mainly arises due to the activity of the second signal system - the speech signal system.

Our discussions when solving design issues can be an example of *abstract thinking*.

Abstract thinking differs from concrete thinking not only in its vastness, but also in the fact that it allows a very deep knowledge of reality. In this way, we can think about the connections and laws related to all things in one sentence. In some abstract discussions, we can think about things that cannot be perceived or imagined. We can think abstractly about objects and things that we have not seen or known until now. We will also be able to think about self-driving cars and their devices.

Abstract thinking is the way to reach the truth and to know reality even deeper and more fully.

Abstract thinking and concrete thinking make up the whole thinking of a person, these two thinking are closely connected with each other. This connection is primarily because abstract thinking has historically developed on the basis of concrete thinking. For example, when determining the third projection of a detail with two projections, its solution can be determined in one option. But what makes a solution multivariate? In fact, this problem arises because the details

of the two projections given are insufficient or unclear. However, additional options arise through abstract thinking, and they are formed from the geometric surfaces we know, that is, from the information in our concrete thinking.

Second, the unity of abstract thinking and concrete thinking is that every concrete thought enters into abstract thought to a certain extent, and every process of abstract thinking relies on concrete thinking. Even the simplest concrete discussions have a moment of abstraction. For example, in concrete discussions "This is a rectangular pyramid with a base" and "This is a rectangular prism with a base", the words "base" and "rectangle" are abstract concepts. Commonality exists only through certain things. Every single thing is common. Any generality is some aspect (part or aspect, or essence) of something.

Depending on the type of thinking, it is divided into theoretical and practical thinking.

Thinking aimed at explaining phenomena is called theoretical thinking. To explain something means to make something unknown known. For this, it is necessary to connect the unknown with the known. Therefore, it is necessary to reveal the connections and relationships between different and certain concepts and to explain these connections in discussions.

In particular, *to explain* means to find the reason of the phenomenon being explained; such an explanation means to include the thing being explained within the scope of the concept of the category to which it belongs, and to show its distinguishing features; means to show the purpose of an event, why it exists, its importance and function.

In *explanatory thinking processes*, several questions are answered, for example: "what is this?"; "why?"; "why is that?"; "what for?"; "What are the similarities or differences between such phenomena or concepts?". For example: "There are cylindrical, conical or hemispherical depressions under plates, bowls, bowls and trays", "Geometric bodies, models, details are created from the shape of geometric surfaces", "Combinations of geometric surfaces are used in the design of objects". In all these examples, connections and relationships between events are noted.

If explanatory thinking is expressed in general (abstract) judgments, such thinking is called *theoretical thinking*. For example, discussions such as "The design of the object being designed will reach a higher level aesthetically", "The useful work coefficient of the object will increase", "The issue of design will increase the spatial imagination of the student", "The issue of design will attract students to creative research" are both *theoretical* and *abstract thinking* at the same time.

As can be seen from the above, in the process of solving positional and metric problems in orthogonal projection, it is necessary to harmonize the psychological state of the student with the pedagogical point of view. Only then will it be possible to achieve the expected result.

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