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SPATIAL THINKING OF STUDENTS WHEN STUDYING GRAPHIC DISCIPLINES

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ПРОСТОРОВЕ МИСЛЕННЯ СТУДЕНТІВ ПРИ ВИВЧЕННІ ГРАФІЧНИХ ДИСЦИПЛІН

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The article examines the problems that students face when studying graphic disciplines. At present, the task of further improving the quality of professional training of students has been set as the most important task for higher and secondary specialized institutions. This involves broad-based training of future specialists and the complex nature of mastering modern theoretical and applied knowledge, the ability to apply the knowledge gained in practice, possession of the necessary skills in a related field. A specialist with a higher education, but without knowledge and skills to receive and process graphic information, may turn out to be incompetent in professional activities. The preparedness of students for graphic activity is determined by the complex of knowledge acquired by them in the learning process, skills of reproductive and creative activity, which in the future determine their successful professional activity. A future engineer must have a high level of general and technical intelligence, well-developed spatial thinking, and have a high level of theoretical knowledge in the field of professional activity. In the system of training specialists for engineering specialties, one of the main places is occupied by the academic disciplines «Engineering Graphics» and «Descriptive Geometry». They contribute to the development of the future engineer of spatial representation, logical and constructive thinking, the ability to analyze and synthesize. Well-developed spatial awareness and imagination are prerequisites for successful learning in many academic disciplines. And the disciplines «Descriptive geometry» and «Engineering graphics» by their content make high demands on the level of development of spatial representations. This article reveals the reasons for the weak development of spatial representations among first-year students of universities. It is proposed to use the developed approach, including tasks, methods and system of exercises, tasks and tests, as one of the ways to successfully develop spatial representations in the study of graphic disciplines. Each group of exercises of this system is aimed at the conscious and active work of students and solves a specific problem arising from the theoretical foundations of the development of spatial representations.

Key words: *thinking, graphic disciplines, spatial representation, exercises, educational process, methods of didactics, analysis, synthesis.*

Introduction. Higher education in the context of the need for constant self-improvement of specialists is aimed at the formation of a professionally active personality with a holistic system of knowledge and practice-oriented methods in their field of activity. Therefore, the education system has a great responsibility for organizing the educational process that ensures the intellectual development of students.

The specific features of applied geometry as a science and as an academic discipline determine its special position among the basic directions of personality development. Mastering the system of scientific knowledge, effective work in many types of theoretical and practical human activity are inextricably linked with the ability to operate with spatial images, that is, with developed intellectual skills.

In the system of training specialists in engineering specialties, one of the main places is occupied by the disciplines «Engineering Graphics» and «Descriptive Geometry». They contribute to the development of a future engineer's spatial representation, logical and constructive thinking, abilities for analysis and synthesis. Well-developed spatial representation and imagination are necessary conditions for the successful assimilation of many academic disciplines.

In addition, engineering graphics is the language of technical communication, a tool for transmitting design information. Through graphic activity, such cognitive processes as feeling, assistance, representation are realized simultaneously. The development of spatial representation is of exceptional importance, because the development of representation, especially visual-figurative and spatial representation, is closely connected with the human intellect.

The main problem of graphic training of engineers at a technical university at present is the discrepancy between the requirements of the state educational standard and the actual volume of classroom hours provided for by the curriculum. Independent work does

not give the desired results: the topics proposed for study are not sufficiently studied by students. Pre-university graphic training is practically absent. All this leads to the fact that most students in solving graphic problems operate with flat, rather than spatial images.

Presentation of the main material. The experience of teaching graphic disciplines shows that the majority of applicants have very poorly developed spatial representations [1, 2], and some applicants do not have it at all. One of the reasons for this is the absence of the "Drafting" subject in many secondary schools or the reduction in the number of hours in this subject.

Undoubtedly, the accumulated experience of students in their representation of the objects shape is also of great importance. They could receive it in the lessons of drawing, geometry, stereometry, geography, physics, chemistry, labor training, etc., Each of these subjects has its own possibilities in the development of spatial representations, therefore, the organization, conduct and pedagogical management of them are of decisive importance, starting from the first year of schooling.

First-year students at the university cannot correctly examine and recognize the geometric bodies that make up the technical detail. At the same time, they experience the greatest difficulty in the case of finding an object in an unusual position for them. Often, students do not notice some elements of details (holes, grooves, chamfers, ribs, etc.), they cannot grasp the general shape of the object, i.e. recognize in it a certain combination of geometric bodies. In addition, many students are not able to mentally move from a visual image to a complex drawing (plot) and vice versa. And with an insufficiently developed spatial representation, it is difficult for students to fully express anything graphically [3].

To eliminate these shortcomings, it is proposed to use the developed didactic approach in the study of graphic disciplines (Fig. 1) [4].

An important place in the developed approach is occupied by such methods of didactics as analysis and synthesis. Analysis allows you to recreate the spatial form of a complex object in parts and thereby simplifies the presentation process itself. The analysis is followed by synthesis. It's bringing together the characteristic features of the object and obtaining a generalized image on their basis.

It is known that spatial representations can be developed in two ways: induction and deduction [5].

The first method involves an initial acquaintance with the spatial properties of the basic geometric bodies, and then, on this basis, a transition to the study of complex spatial forms, which are a combination of geometric bodies. Thus, the process of cognition proceeds in accordance with well-known didactic rules: from the simple to the complex, from the known to the unknown.

The second method involves the selection by analysis of objects of complex shapes of individual geometric bodies, the shape of which should be considered. In this case, the bodies from which the shape of the object is created are not isolated, therefore, their shape is not fully captured due to uncertainty [6]. Therefore, the ability to mentally divide the shape of a complex object into simple geometric bodies is the main skill in the representation of the form, which must be used in the development of spatial representations.

To form spatial representations in the course of studying graphic disciplines, it is necessary to solve the following tasks:

- to develop in students the ability to clearly reproduce mentally the shape of geometric bodies known to them or real objects when constructing and reading machine-building and construction drawings;
- expand the boundaries of spatial representations, consolidate and bring them into a certain system.

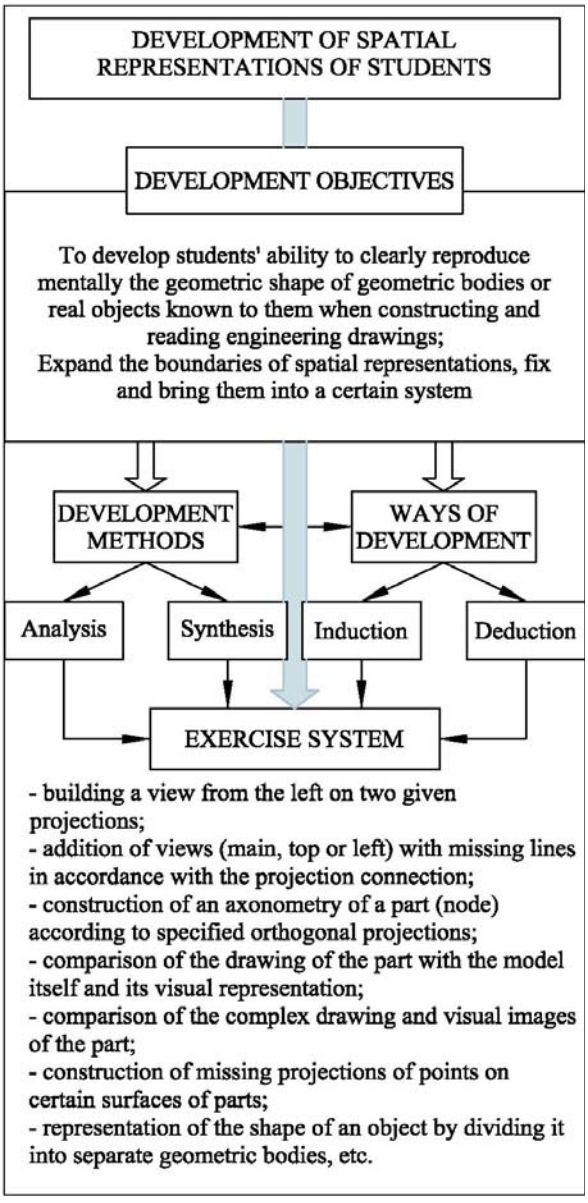

Fig. 1. Didactic approach to the development of spatial representations of students in the study of graphic disciplines

One of the ways to successfully solve these problems in the study of graphic disciplines is the

proposed system, which includes several groups of exercises, tasks and tests.

In this system, teachers should pay great attention to the selection of tasks. When studying any new section, for illustration, you first need to use drawings that show objects that are simple in form and well known to students. Gradually, the tasks should become more difficult. As the studied material is assimilated, it is advisable to move on to individual tasks [7-8]. For this purpose, a variety of tasks with the necessary number of options are offered.

When creating a system of exercises, it is proposed to be guided by the rule according to which exercises of each type solve a specific problem arising from the theoretical foundations for the development of spatial representations.

The first group of exercises is building a view on the left according to two given projections (Fig. 2). These exercises contribute to the development of students' skills aimed at representing the form of the object as a whole and its individual parts in two types. They can get more difficult as you gain skills.

The second group of exercises is the addition of views (main, top or left) with missing lines in accordance with the projection connection. According to the unfinished drawing, students find it difficult to determine the shape of objects. Therefore, there should not be too many missing lines so that they can solve the problem. These exercises can be practiced both independently and as an integral part of other exercises (see Fig. 2).

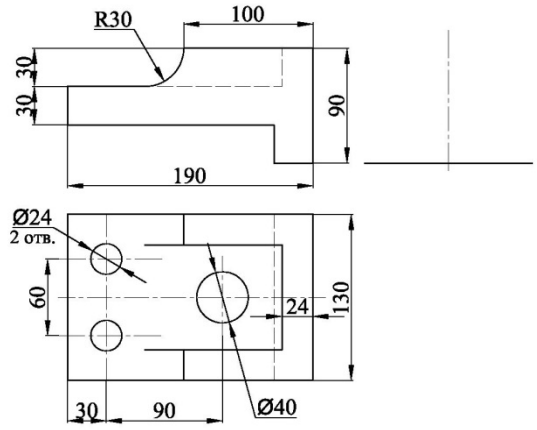

Fig. 2. Example exercise: complete the front view and the missing left view. Make the necessary cuts

The third group of exercises is building an axonometry of a part (assembly) according to given orthogonal projections (Fig. 3). It is a more difficult task for a student, since it requires reproducing the shape of an object according to its projections. The value of this exercise lies in the fact that after performing a visual image, the student more clearly imagines the shape of the object (node) depicted in the drawing. Such exercises contribute to the formation in the minds of students of certain connections between flat and three-dimensional images and, consequently, the development of spatial representations.

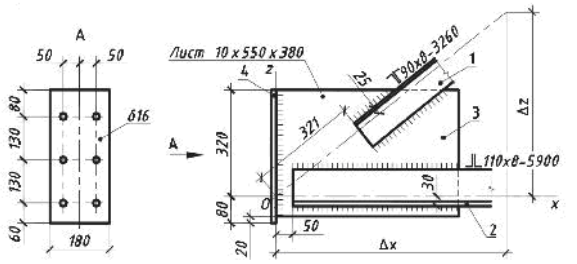

Fig. 3. Example exercise. To construct a rectangular isometry of node 1

The fourth group of exercises is a comparison of the detail drawing with the model itself and its visual representation. The student must find among a certain number of models of the part the one shown in the drawing. In this case, the shapes of the models differ only slightly from the shape of the depicted part. Such exercises develop skills in highlighting the most characteristic features of the shape of objects in the analysis, memorizing them and comparing them with the image. This group of exercises also includes tasks for finding a given part from visual images of a drawing.

The fifth group of exercises is a comparison of a complex drawing and visual images of a part with fixing the attention of students on individual elements of the subject. For example, students are given a visual representation of an object and its three types. Each face in the visual image is indicated by a letter or number. It is required to designate the corresponding planes on three projections. This group includes tasks, for the solution of which it is necessary to apply dimensions taken from a visual image or vice versa on three types of parts.

The sixth group of exercises is the construction of the missing projections of points given on certain surfaces of parts. When solving such problems, students determine the projections of the faces on which the given points are located. Gradually, from points, you can move on to segments, flat figures.

The seventh group of exercises is the representation of the shape of an object by dividing it into separate geometric bodies. For example, the student must name the geometric bodies that make up the object; indicate their boundaries on the proposed views of the detail drawing or show the boundaries of the details on the assembly drawing.

Teachers of technical universities should use pedagogical techniques to develop students' spatial imagination and thinking, the ability to see spatial images, combine them when solving various design problems.

In this regard, we will consider two approaches in the development of modern graphic disciplines.

The traditional approach is based on the development and creation of a product drawing, while the computer is used as an electronic drawing board,

which improves the quality of design documentation and speeds up the design process itself.

The main place in this approach is occupied by the drawing of the model, which serves as a means of its presentation. The product drawing contains information for solving various geometric and technical problems, and also serves as the basis for further manufacturing and operation of the product (Fig. 4). In the traditional approach to design, reference, design and technological documentation is the basis for the transfer of information.

The basis of **the innovative approach** is a three-dimensional model of the product (Fig. 5). Visualization capabilities make it more visual, and tools are added to solve engineering problems in an automated mode.

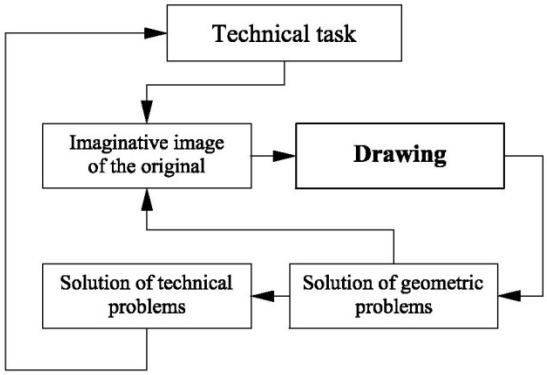

Fig. 4. Traditional approach

A three-dimensional model of an object (product), containing information about the geometry of the object, is used to obtain a drawing, as well as to calculate various characteristics of the object and technological parameters during manufacture. Methods for creating a drawing are based on the capabilities of computer graphics and methods for transforming a spatial model.

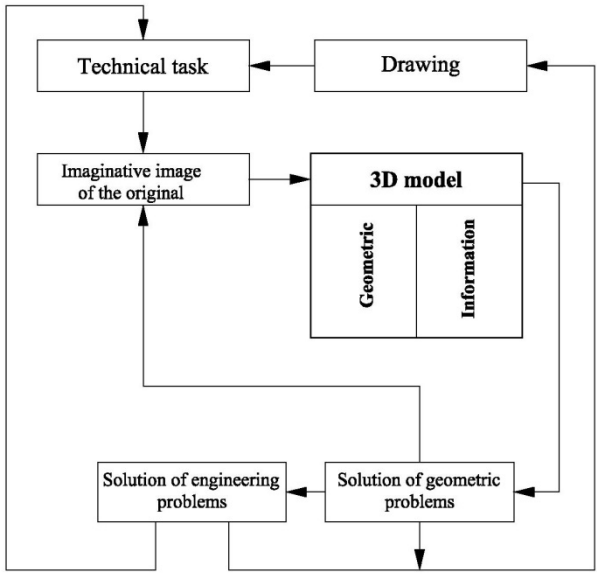

Fig. 5. Innovative approach

In an innovative approach, the transfer of information about models of geometric objects occurs on the basis of a computer representation of objects. The use of computer technologies in the educational process forms an information-graphic culture, develops the ability of design activities. The effectiveness of the use of these technologies does not cause doubts. The solution to problems in the study of graphic disciplines is the restructuring of the entire course using 3D modeling methods from the very beginning of training. The main emphasis in this approach is on the analysis of geometric shapes.

At the initial stage of training, there will be a study of 3D modeling: the construction of three-dimensional solid and surface objects and their orthogonal projections (the system allows you to make these constructions automatically). The experience of teaching modeling shows the need to perform special exercises “from simple to complex”. At the same time, the student must be able to imagine a detail as a complex of its constituent elements. The task of the teacher is not only to help the student understand and master the logic of modeling, but also to form the skills of constructive analysis of the shape of the part. The student studies the ways of shaping, masters editing operations to create a model. In the classical course of descriptive geometry, it is proposed to replace the solution of similar positional, metric problems with 3D modeling technologies. Consideration of such topics as surfaces, methods of their formation, section of a surface by a plane, section of surfaces, study of the nature of the section line depending on the relative sizes of surfaces, axonometric projections, which can be represented using 3D modeling [9-10].

Conclusions. The study of graphic disciplines allows to depict objects, to develop spatial and logical thinking. Methods of teaching descriptive geometry and engineering graphics, which have been practiced for decades, are ineffective in changing living conditions.

Therefore, using the proposed types of exercises in the educational process, we can conclude that students, considering a technical detail or a node in the form of a combination of geometric bodies and individual elements, learn analysis as a research method and thereby improve their spatial representations.

If possible, it is advisable to start with the analysis of simple parts and assemblies, gradually moving on to more complex ones. In addition to lectures, practical exercises, these exercises can be used to check the quality of mastering certain topics of the discipline, defending settlement and graphic works, and compiling test tasks for intermediate certification.

Should also be taken into account that the formation of a geometric model is a stage that determines the further process of solving engineering problems, which is becoming more and more automated. Such a graphic preparation technique will reflect the trends of computer-aided design and meet the requirements for modern engineers.

Quantitative and qualitative indicators of the results of the work done indicate that the integration of computer graphics into graphic disciplines is relevant and interesting. Revealing the scope of tasks in the relationship between traditional and innovative technologies in design, we get the opportunity to move on to building distance learning systems. The latter is of particular importance in the formation of systematic geometric thinking. Traditional and innovative approaches should be mastered in conjunction, taking into account their joint development.

The use of this technique contributes to the development of the necessary spatial representations in students. All this enhances the culture of geometric and graphic training of students, thereby creating the necessary basis for further study of graphic disciplines.

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Карпюк Л.В., Давіденко Н.О. Просторове мислення студентів при вивченні графічних дисциплін

У статті розглядаються проблеми, які виникають у студентів при вивченні графічних дисциплін. В даний час найважливішою задачею перед вищими і середніми спеціальними закладами є завдання подальшого підвищення якості професійної підготовки студентів. Це передбачає широкопрофільну підготовку майбутніх фахівців та комплексний характер оволодіння сучасними теоретичними та прикладними знаннями, уміння застосовувати отримані знання на практиці, володіння необхідними навичками у суміжній галузі. Фахівець із вищою освітою, але без знань та навичок отримувати та обробляти графічну інформацію, може виявитися некомпетентним у професійній діяльності. Підготовленість студентів до графічної діяльності визначається комплексом набутих ними у процесі навчання знань, умінь репродуктивної та творчої діяльності, які у майбутньому визначають їх успішну професійну діяльність. Майбутній інженер повинен мати високий рівень загального і технічного інтелекту, добре розвинене просторове мислення, мати високий рівень теоретичних знань у сфері професійної діяльності.

У системі підготовки фахівців інженерних спеціальностей одне з основних місць займають навчальні дисципліни «Інженерна графіка» та «Нарисна геометрія». Вони сприяють розвитку у майбутнього інженера просторового уявлення, логічного та конструктивного мислення, здібностей до аналізу та синтезу. Добре розвинене просторове уявлення та уява є необхідними умовами успішного засвоєння багатьох навчальних дисциплін. А дисципліни «Нарисна геометрія» та «Інженерна графіка» своїм змістом висувають високі вимоги до рівня розвитку просторових уявлень. У статті розкрито причини слабкого розвитку просторових уявлень у студентів першого курсу вузів. Пропонується використовувати як один із шляхів успішного розвитку просторових уявлень при вивченні графічних дисциплін розроблений підхід, що включає завдання, методи, способи та систему вправ, завдань і тестів. Кожна група вправ цієї системи спрямована на свідому та активну роботу студентів і вирішує певне завдання, що випливає з теоретичних основ розвитку просторових уявлень.

Ключові слова: *мислення, графічні дисципліни, просторове уявлення, вправи, навчальний процес, методи дидактики, аналіз, синтез.*

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