LEVELS AND CRITERIA OF DEVELOPMENT OF STUDENTS' SPATIAL REPRESENTATION IN TEACHING GEOMETRY

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ABSTRACT

In the paper it is considered the ways and problems of developing spatial representations of the students in teaching geometry.

Keywords: Geometry, reader, spatial imagination, criteria, stereometry, scientific worldview, cube, diagnostic, constructive, developmental issues.

INTRODUCTION, LITERATURE REVIEW AND DISCUSSION

Researchers are conducting research on issues, drawings, etc., that serve to develop students' spatial imagination from engineering graphics, descriptive geometry, stereometry. For example, in 2011 Eshpulatov N., Saparboev J., Davletov D. published a set of issues aimed at developing students' spatial imagination [1]. The development of a system of questions aimed at developing students' spatial imagination on topics related to planimetry and stereometry remains a pressing issue. To solve this problem, the teacher is required to develop a perfect methodological system of problems.

It is known that the goals and objectives of teaching geometry in academic lyceums can be expressed as follows [2]:

1. To form students' scientific worldview, to acquaint them with the role and importance of geometry in scientific knowledge of the world, as well as mathematical abstraction and the differences between the real world;
2. Ensuring that students acquire such knowledge and skills firmly and consciously through the formation of a system of geometric knowledge and skills;
3. Equip students with geometric knowledge, skills and competencies that will be needed in their daily lives and future careers;
4. Equipping academic lyceums with geometric knowledge, skills and abilities necessary for the study of other disciplines;
5. Formation and development of spatial imagination in students;
6. Ensuring the overall development of students through the formation and development of logical thinking.

G.D. Glazer believes that the structure of students' mental activity in the field of geometry consists of the following interrelated components: intuitive, spatial, metric, logical, constructive, symbolic components. [3]

It is known that the content of teaching geometry is mainly reflected in textbooks. In geometry textbooks, the above 6 components are reflected to varying degrees. Different scholars have expressed different views on these components.

For example, A.D. Alexandrov believes that geometry and, most importantly for all, “rigid logic + vivid perception”, but it is possible to sacrifice logical precision and validity for visualization. He also emphasized that the teaching of geometry included the visual representation of logic, the application of geometry to life [4].

An analysis of various textbooks shows that according to almost all authors, one of the main tasks of teaching geometry is the formation and development of geometric concepts in students. This is not only an internal problem of the geometry course, but also an external task related to preparing students for the study of other disciplines, life, work, socially useful work. The ability to perform actions on spatial images characterizes the level of intellectual development for a person.

1. It should be noted that spatial perceptions as an internal function of geometry are very important in solving various practical and theoretical problems in the study of teaching materials in the discipline of geometry.

2. The formation and development of spatial imagination of students of academic lyceums is concentrated primarily as a result of studying the geometric material in the program, as well as showing the models of simple geometric figures of the surrounding objects, generalizing geometric objects and facts under the guidance of the teacher. At this stage of education, the foundation is laid for the formation of students ’spatial imagination. Academic lyceum students can be offered a cube, a right-angled parallelepiped, a right prism, a triangular regular pyramid, a curved prism, a cylinder, a cone, and a sphere for learning. Students will be able to recognize these objects and make comparisons with each other; should be trained to perform simple measurements. Particular attention should be paid to observing students and drawing conclusions from observation results.

3. As students begin to study the course of planimetry, they will have more developed three-dimensional representations than two-dimensional ones. It is in this case that in the formation of spatial representations in students, attention should be paid to the fact that planimetric figures are a special case of stereometric figures.

4. In the study of planimetry, it is necessary to search, establish, and show students the connections between planimetric figures and spatial figures and objects in the environment.

5. It is advisable to use diagnostic, constructive, graphical and generalizing problem types to form spatial representations in students:

1. Diagnostic questions are questions about activating students' perceptions of objects that are already known to them.

The purpose of using such issues is to determine the level of formation of spatial perceptions in students and to identify and correct misconceptions in a timely manner.

2. Constructive problems - in the process of solving such problems the conditions of material origin of geometric figures are revealed to students.

The main purpose of using such issues is to highlight the important features of the emerging perceptions.

3. Graphic problems - the representation of geometric figures through drawings, sketches, sketches, and the creation of figures by its characteristic properties, and the creation of drawings in a system of right-angled projections.

The purpose of using graphical problems is to identify the causes of incorrectly formed spatial perceptions, to distinguish the important features from the unimportant ones.

6. Generalization problems - such problems serve to clarify students' perceptions of spatial figures in order to distinguish them from other objects that have a given property. The main problem of the generalization question is "Does the given model correspond to the scope of the given concept?" - to answer the question.

The main purpose of the generalization problems is to determine the completeness, comprehension, and level of accuracy of the formation of spatial representations.
One of the most important means of knowing the objective being, the surrounding world, in the study of the course of stereometry is the creation of images of three-dimensional objects and the very favorable conditions for performing operations on them.

Everyone knows that there are great difficulties in the transition from the study of planimetry to the study of the course of stereometry. Because there are no ready-made algorithms in solving or proving every problem in the stereometry course, almost every one of them has to be considered as a new problem. This situation is especially exacerbated when spatial perceptions are not sufficiently formed.

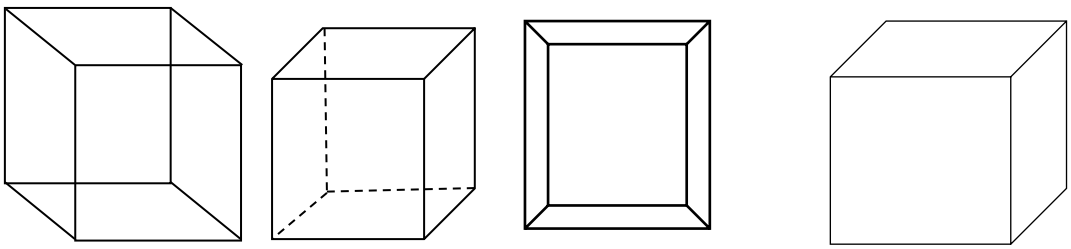
The development of spatial perceptions during the study of the course of stereometry should be carried out mainly at the expense of the propaedeutic course of teaching geometry and the filling of the perceptions formed during the study of planimetry.
In order to form and develop students' spatial imagination, it is necessary to use the following two types of questions:

a) tasks on creation of spatial images;
b) assignments to perform operations on spatial images.

It should be noted that such a separation of issues is conditional, and requires that both of them be able to perform operations on previously formed spatial images.
The formation of images is based on the visual, and the work on the images, without the visual, imagines the original content. In the study of stereometry, great attention should be paid to the formation of the ability to see objects in the form of geometric figures in the surrounding world.

For example, we note that it is important in the development of spatial imagination to look at unusual examples, such as a student's ruler - a right-angled parallelepiped, a coin - a cylinder, a tank - a cylinder, a funnel - two truncated cones. As new geometric shapes are introduced, students need to be taught to distinguish complex objects into simpler ones.

One of the important tools in developing students ’spatial imagination is drawing. The main focus should be on developing the skills of depicting three-dimensional figures through drawings in a plane. In this case, it is expedient to consider different images of the same object. An example of this is the drawings of the cube in different shapes.



It should be noted that in geometry, there are three types of drawings: a) drawings that represent the content of the concept being introduced; b) drawings depicting the condition of the problem; c) drawings representing the substitution of geometric figures.
Here are the main directions of improving the methodology of developing students' spatial imagination in teaching geometry:

1) It is advisable to regularly study flat figures in different positions in space, taking into account figures that are familiar to students of life and practice in school.

2) The use of spatial images of non-flat geometric figures to solve problems of a planimetric nature.

3) When studying the geometric positions of points in a plane, it is necessary to look at such points in space as well as the experimental intuition of students.

4) Involve students in the preparation of drawings of distributions and models of geometric figures.

5) In the process of teaching the course of planimetry, it is necessary to systematize the stereometric data that students have learned in the lower grades and acquired in the course of life practice.

6) One of the ways to improve the methodology of formation and development of spatial representations is to study geometric transformations in the course of geometry.

7) One of the important directions in the development of spatial imagination is the study of vectors and their applications.

8) Systematic approach to the study and memorization of the properties of flat figures in the teaching of stereometry

9) The use of visual aids in teaching geometry.

10) Make regular connections in teaching geometry and drawing.

11) The use of analytical methods, especially differential and integral calculus, along with geometric representation, is of special importance in the development of students' spatial imagination.

12) The course of geometry, built on a strict logical basis, has a wide range of opportunities for students to form non-Euclidean spatial concepts.

Here are some of the issues aimed at developing spatial imagination.

1. Indicate the geometric position of the points lying at equal distances from the ends of the given section in space.

2. Indicate the geometric position in this plane of points equidistant from the sides of a given angle in space [5].

4. Draw two corners in the oil of the cube that have a common three and a side.

5. Is it possible to make an equilateral triangle whose side is equal to the edge of the cube in the oil of the cube [6].

When we gave these questions to students of academic lyceums in the field of specific sciences as a written work, it became clear that in groups the spatial imagination of students is formed at different levels. Table 1.

Table 1.

№	Group name	High level	Medium process	Low level
1.	АФ-81	25%	45%	30%
2.	АФ-82	20%	35%	45%
3.	АФ-83	15%	40%	45%

Higher level - students are able to write the correct answer to the problem in the allotted time, ie without drawing, or write additional (complementary) drawings and write the correct answer to the problem;

Intermediate level - the student is able to solve problems using geometric models, drawing diagrams in a timely manner;

Low-level - even when students are allowed to use teaching aids, available electronic resources, and geometric models, problems are partially solved incorrectly.

Issues for lower levels

1. The diagonal of a straight parallelepiped is 13 cm, the diagonals of the sides $4\sqrt{10}$ sm $3\sqrt{17}$ sm If so, find its size.

2. The sides of a rectangular parallelepiped base are 3 and 4. The diagonal base is 450 angles to the plane. Find the side surface of the parallelepiped.

3. The sides of a straight parallelepiped base are 2 and 8 and form 300 angles. If the side surface is 10, find the size of the parallelepiped.

4. If the side of the base of a regular triangular prism is 2, the side surface is equal to the sum of the bases of the bases, find its volume.

5. If the edge of a cube is equal to 2, find the sum of its diagonals.

Issues for intermediate level

1. $ABCDA_1B_1C_1D_1$ cube A_1C_1D cut through the ends. This is in proportion to the volume of the cut cube.

2. The diagonal of a right-angled parallelepiped is 1 and 300 angles with side oil make 450 angles with other side oils. Find the size of the parallelepiped.

3. The base side of a prism consists of a square equal to 1. Find the full surface of the prism, one side of which is a square, the other a 600-rhombus rhombus.

4. The base of a straight prism consists of a triangle with sides 5cm, 5cm and 8cm. The lower base of the prism makes 300 angles with the large side and the plane passing through the middle of the opposite side edge to the base of the prism. Find the cut face.

5. If the center line is 8 cm, one base is 6 cm longer than the other base, and the base of a straight prism with a trapezoidal height of 8 cm with a sharp angle of 450 cm, find the full surface of the prism.

6. All sides of a triangular prism are equal, 1m each. One end of the upper base is projected to the point of intersection of the medians of the lower base. Find the side surface of the prism·

7. $ABCDA_1B_1C_1D_1$ cube edge $\sqrt{3}$ equal. CB_1 and A_1B Find the distance between the edges.

8. $ABCDA_1B_1C_1D_1$ cubic BD_1 diagonal and ABC find the angle between the planes.

9. $ABCA_1B_1C_1$ prism height 12 sm. ACB_1 plane ABC with plane 45^0 forms a corner. If $\angle ABC = 90^0$ and $BC = 15$ and If so, find the side surface of the prism.

Issues for higher levels

1. Let a regular triangle with side 2 cm ABCA1B1C1 be the base of a triangular prism. If $\angle AA_1C = \angle A_1AB = 60^0$ and $AA_1 = 1$ if the, find the height of the prism.

2. The base face of a regular rectangular prism is 117, the side edge $2\sqrt{13}$. The diagonal of the prism and the side of the base that does not intersect with it find the distance between.

3. The edge is equal to 1 $ABCDA_1B_1C_1D_1$ cube da B Find the distance from the point AS_1 to the straight line.

4. Find the distance between the straight lines AB and CA_1 in the cube $ABCDA_1BCD_1D_1$ with edge 1.

If the teaching of geometry is organized first by determining the level of spatial imagination of students, and then based on the results obtained, it will be much easier and more effective for students to master the knowledge of geometry. The science of geometry needs to be organized in this way. The development and organization of methods and tools for the development of students' spatial imagination in the process of teaching geometry is another problem of research.

Creative geometry lessons require a creative approach from the teacher. Therefore, the teacher is entrusted with the high task of cultivating an active, creative and inquisitive person.

The development of spatial imagination is important not only for the effective implementation of the educational process, but also for the implementation of educational work, which ultimately plays an important role in developing students' mental abilities, respect and enthusiasm for the future profession.

It is also effective to divide the given figures into partial figures, to create new figures for the development of spatial imagination.

In order to form and develop spatial perceptions in students, certain tasks must be carried out by the teacher on a regular, systematic and purposeful basis.

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