RESEARCH PARKS

INTERNATIONAL JOURNAL OF HUMAN COMPUTING STUDIES

https://journals.researchparks.org/index.php/IJHCS e-ISSN: 2615-8159 | p-ISSN: 2615-1898

Volume: 05 Issue: 03 | Mar 2023

The Role of Spatial Imagination in the Step-By-Step Description of the Solving of Multiple Problems in Drawing

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Abstract: In this article, it is described how to show graphic operations in solving problems related to sections of polynomials, to develop students' spatial imagination.

Keywords: Polygon, surface, drawing geometry, education, method, education, spatial perception, positional and metric problems, figure, academic lyceum, section.

The issue of developing students' spatial imagination has always been one of the urgent and complex issues. Little attention is paid to the development of students' spatial imagination in the topics of drawing classes in academic lyceum curricula on polynomials.

In this article, it is explained that it is possible to develop the spatial imagination of academic lyceum students, based on the step-by-step description of each graphic operation on the computer, using the capabilities of modern graphic programs when making sections in spatial figures.

Learning to make cross-sections of spatial figures has always been a complex process. There are various methods of constructing sections in polynomials, and the use of these methods depends, of course, on how the construction problems are posed. Among these problems, the problems that require making sections of spatial bodies with planes in different situations are especially important. This process can be demonstratively and efficiently carried out in teaching based on computer technologies.

With the help of graphic programs, for example, AutoCAD, it is possible to follow not only the finished section, but also the stages of making this section, and on this basis to activate the spatial perception. Of course, effective implementation of this requires teachers to have knowledge of graphic programs and the ability to apply them to the educational process.

The logical and methodical significance of the step-by-step visual representation of the graphic actions in the process of solving problems in making sections in polynomials is very great in the development of spatial imagination of pupils and students.

The following issue mainly concerns polyhedra, which can be used as additional materials in drawing classes in order to develop the spatial imagination of academic lyceum students.

Problem: In the middle of the edges AB and AD of the pyramid MABCD, we mark the points P and Q, respectively, and we take the point R on the edge MC. Make a section of the pyramid with a plane passing through the points P, Q and R, Fig. 1.

First, we will create an algorithm for solving the problem. This process is a process that takes place in our mind and requires a lot of spatial thinking, that is, the ability to think spatially and logically, as well as to know the properties, definitions and theorems related to geometry. Therefore, the analytical formulation of the problem-solving algorithm is of great importance as a factor that increases the spatial imagination of pupils and students.

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Volume: 05 Issue: 03 | Mar 2023

Therefore, logically and methodically developed algorithms provide optimal graphical solutions to problems.

Analysis: According to the problem given in figure 1, the plane does not intersect with the edge MA. MS intersects the edge at point R. To perform the desired section, it is necessary to determine the points where the edges MV and MD intersect with the plane PRQ. To do this, it is enough to find the point F common to the planes MVD, MAS and PRQ by passing the planes passing through the edges MV and MD and the base diagonalAS and VD.

Since the traces of the planes MVD and PRQ on the base of the pyramid are parallel to each other, their line of intersection through the point F is also parallel to these traces. This intersection line intersects the edges MV and MD, giving two points of the intersection line. By connecting the found points with P and R and Q and R, the desired section is formed.

Making:

1. The trace of the plane AVCD in the plane (PRQ) is a straight line PQ.
2. We pass the MAS plane, Fig. 2. Its trace in the plane AVCD will be AS. Let's make a point K, the point of intersection of straight lines AS and PQ. The points K and R belong to the planes PQR and MAC at the same time, therefore, passing the straight line KR, we form the line of intersection of these planes, Fig. 3.

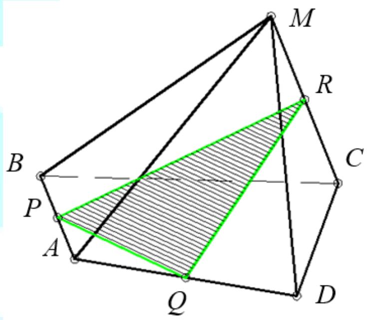

Fig. 1

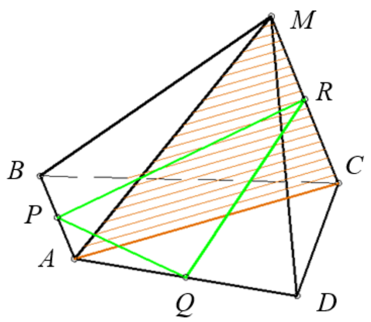

Fig. 2

3. The VMD plane is crossed with the MAS plane. For this, we find N points: N =AC∩BD and make a straight line MN. Then we make the point F: F=KR∩MN, Fig. 4. Because the straight lines KR and MN lie in the same plane MAS.

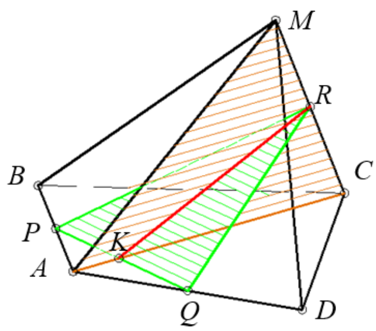

Fig. 3

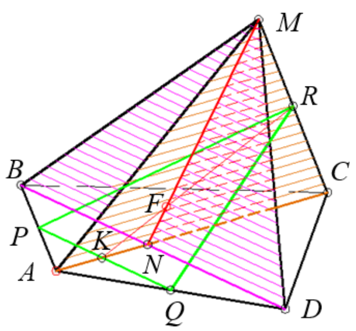

Fig. 4

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4. Point F is considered the common point of the planes PQR and MDB, that is, the intersection of these planes lies on the line KR. Since PQ – ABD is the midline of the triangle, the straight line PQ is parallel to BD. It follows that the straight line PQ is parallel to the plane MDB. Then the plane PQR passing through the straight line PQ intersects the plane MDB in a straight line parallel to PQ and therefore also to BD. Therefore, we draw a straight line parallel to BD or PQ through the point F in the plane MDB. This straight line intersects the sides MV and MD at points V' and D', respectively, Fig. 5. Connect V' with points R and R and D' with points Q and R using a thin line, Fig. 6.

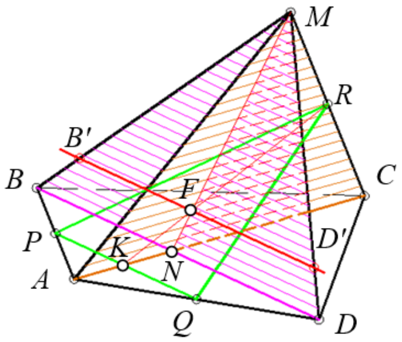

Fig. 5

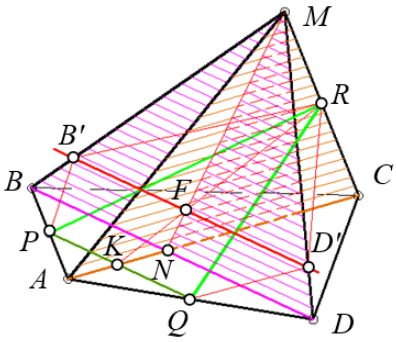

Fig. 6

5. By determining the visible and invisible parts of the section line, the section lines PQD'RB' are rounded. It is sought, that is, the given plane PQR will be the section of the pyramid MABCD, Fig. 7.

If the analysis of the problem is thought more deeply, it can be determined that there is a second more appropriate way to solve this problem. Therefore, we consider the first method of solving the above problem.

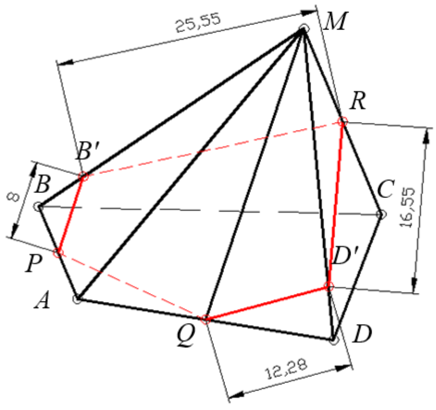

Fig. 7

Solving the problem of the above-mentioned type develops students' imaginations about the structure of spatial bodies, allows them to understand the essence of the theorems about the mutual situation of straight lines and planes in space, and learn their application. Positional and metric problems related to intersections of spatial figures with planes in the teaching of topics such as "Parallelism of straight lines and planes in space", "Perpendicularity of straight lines and planes in space", "Angles between a straight line and a plane in space, between two planes, between two straight lines" serves as demonstration material.

Making cuts develops students' spatial and logical thinking, and also helps to expand their spatial imagination. The use of intersections allows solving problems using relatively short algebraic substitutions, relying only on geometric constructions, without performing lengthy calculations. When solving complex problems, using the method of sections allows you to solve them without spending a lot of time with the help of several additional constructions. The method of sections is considered a non-standard method for solving problems, in which the problem is solved using simple theorems, properties and axioms of geometry with the help of uncomplicated additions.

Thus, it is possible to form and develop students' spatial imagination by using the method of step-by-step description of each graphic operation in geometry lessons. Also, this method helps to increase the professional competence of future specialists.

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