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ANALYSIS AND THEORIES OF PROJECTIVE GEOMETRY

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Abstract:

A number of interesting geometric applications of the theorems proved are presented as problems. In particular, the famous Pascal's theorem was formulated as a problem in terms of Euclidean geometry. In this theorem, which has a projective nature, only the relation of belonging of points to straight and conical sections is used. The above once again confirms the importance of the course "Projective geometry" in the preparation of a mathematics teacher at a pedagogical university.

Keywords: Projective geometry, Constructive Geometry, Pythagorean theorem, Papp-Desargues, Euclidean geometry

In Appendix 4 to the geometry textbook for grades 7-9 of general education institutions [1], entitled "Some remarkable theorems of planimetry," proofs of the theorems of Cheva and Menelaus are presented. A number of interesting geometric applications of the theorems proved are presented as problems. In particular, the famous Pascal's theorem was formulated as a problem in terms of Euclidean geometry. In this theorem, which has a projective nature, only the relation of belonging of points to straight and conical sections is used. The above once again confirms the importance of the course "Projective geometry" in the preparation of a mathematics teacher at a pedagogical university. The study of the geometry of projective space contributes to the formation of a general geometric culture of the future teacher of mathematics, allowing to clearly show that "projective geometry is all geometry" (Arthur Cayley) [2].

One of its sections is devoted to the basic facts of projective geometry. In [3], the geometry of a projective space is given in a vector presentation according to Weyl's scheme, and the study of projective transformations of the plane allows us to consider, proposed by F. Klein, the group point of view on the subject of projective geometry. Therefore, when compiling a collection of problems, the author proceeded from the importance of studying fundamental theorems of projective geometry, revealing its "perspective origin" and allowing to look at Euclidean geometry from a projective point of view. In particular, Papp's theorem implies a solution to the problem of planting nine trees in nine rows, three in each row. Desargues's theorem implies a solution to a similar problem. The Papp-Desargues theorem reveals the property of a complete four-vertex, related to the projective transformation of a line, and is used to prove a theorem that is a generalization of the well-known Cheva theorem. The study of such theorems of projective geometry and their consequences seems to be necessary for future teachers of the foundations of Euclidean geometry.

The main tool in the study of mathematics at school is a notebook in a box. Are we making full use of the possibilities of this notebook? The Pythagorean theorem and the properties of Pythagorean triangles make it possible to build drawings in a notebook quite accurately and accurately using only one ruler or by hand. At the same time, we pay attention to the fact that as many vertices of the shape that we are building as possible are in the grid nodes.

Drawing for the proof Anarization of the Pythagorean theorem is not only easily reproduced on checkered paper, but also serves as the basis for many constructions, such as:

- from a point not lying on this straight line, lower the perpendicular;
- at a point lying on a given straight line, restore the perpendicular;
- construction of the heights of the triangle;
- construction of right-angled triangles in the case when their legs do not lie on the grid lines;
- construction of a circle; etc.

Pythagorean triangles allow us to construct the angle of interest to us with any degree of accuracy. This makes it possible to develop sufficiently accurate construction of any regular polygon in a notebook in a box. The properties of other geometric shapes further expand the usability of this versatile tool.

One of the new directions of informatization of education is associated with the use of a computer as a cognitive tool. This direction is based on the idea of using active software environments in education without built-in learning technologies with a rigid structure for the user to follow them. While studying in such an active environment, the user himself fills it with the necessary specific objects and their properties corresponding to the studied subject area.

In a number of studies, it is argued that databases, spreadsheets, semantic networks, programming languages, some professional packages of general and special purpose belong to such tools. However, most of them cannot be used in the school geometry course. We have considered several software tools that are recommended by developers as teaching and monitoring systems in school and university geometry courses. It turned out that some of them can be effectively used as tools of cognition, and in the course of geometry not only at a pedagogical university, but also in schools.

First of all, these include software products of dynamic geometry: Cabri Geometry (France) and Geometer's Sketchpad (USA). In our opinion, the "Constructive Geometry" (CG) system is the leader among domestic software tools. It can be used not only as a special tool for solving a large class of geometric problems, but also as a powerful cognitive tool in school and university geometry courses. Let us dwell on this function of the CG system in more detail.

In the practice of our work at the Pedagogical University, the Lyceum of Management, Economics and Law No. 4 and the School-Laboratory No. 24 of Namangan, one of the functions of the CG system was used, which gives the teacher (teacher) the opportunity to create tasks himself in the task editor, compose help for students, draw up answer and comments. After the students (pupils) passed the traditional stages of the system associated with its didactic functions, they were taught by us to create tasks independently, i.e. the role assigned to the teacher. Only after the trainee created in the CG system a certain number of problems for the application of one method or another, he received strong skills in solving geometric problems by this method and, at the same time, strong user skills.

From year to year, students have difficulties in establishing a correspondence between spatial figures and their depiction on a plane. Indeed, in this case, one should compare the image on a two-dimensional plane and a three-dimensional space, the cognition of which is carried out with the help of the senses. The geometry of space is learned by a child mainly with the help of a visual analyzer[7]. But does the child really perceive the space around him as it is?

The optical system of the eye gives on the retina a flat image of the objective space that the child is looking at. The brain, analyzing the emerging retinal image and transforming it based on the student's personal experience, builds a new three-dimensional space, which is called perceptual. The brain, as it were, brings the visible form of an object closer to its true form, seeks to bring its knowledge about the object into a visible image, to clarify it. In psychology, this phenomenon is known as the mechanism of constancy of perception[8].

In this regard, the question of the image of space is of particular interest, since in this case the three-dimensional space is transferred to the two-dimensional plane. A child, trying to depict a three-dimensional figure, will rely on the images that have arisen in the perceptual space, that is, on the visual image and his personal experience. He is faced with the task of displaying in the figure all the essential properties of the figure, but this is impossible due to mathematical laws[9]. So, transfer on the plane the apparent values of the angles of the faces converging in top, it is impossible, their sum will be less than 360 °. Therefore, there is a question about the occurrence of certain deviations of the image from natural visual perception, which are the consequences of irresistible mathematical laws. The problem is overcome by distorting the image where it will cause the least "harm". A certain set of special methods has been developed to depict the space "correctly". However, the establishment of a correspondence between the image of the figure and its generally accepted image will cause great difficulties for children. Only gradually, under the influence of adults, the child overcomes them, but this does not happen immediately. It is necessary to teach the student to see a certain spatial figure and recognize it in a two-dimensional image[10].

Currently, a search is under way for such a means that would help the child in the transition from the perception of space to its image, transformed by the brain (from an object to its image) and vice versa. Modern computer technologies can be of great help in solving the problem under consideration. After all, the capabilities of a computer as a means of teaching, in a number of indicators, far exceed the capabilities of traditional means of implementing the educational process. In particular, we can talk about the consideration of geometric space in motion. It is this opportunity that should make it possible to establish a connection between a three-dimensional space and a two-dimensional image[11].

At first glance, the student also sees a two-dimensional image of a figure on the screen, which is no different from its image on a board or sheet of paper[12]. However, having "revived" the image with the help of special computer tools, the student has the opportunity to compare this image and the studied figure, to make sure that the depicted figure and the image of the figure in question have the same properties[13]. For this, it is advisable to use a demo with animation. So, by rotating the figure or examining its development (disassembling the figure into its components or assembling it from parts), the student will be able to eliminate the inconsistencies that have arisen between the image and the image of the figure. The computer will allow to combine both the model and the image into a single whole, thereby making a painless transition from space to plane and vice versa.

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