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CONSTRUCTING GEOMETRIC FIGURES IN GEOGEBRA

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Abstract: *The paper describes and analyses some problems on constructing stereometric figures and inserting dynamic text for obtaining area and volume by using the interactive mathematics software GeoGebra. Constructing geometric figures and their elements – vertices, edges, base, lateral faces, etc. is easier and clearly illustrated by GeoGebra. In the paper constructing geometric figures is given step by step, accompanied by some images of algebraic window, Graphics View and 3D Graphic View. Via dynamic toolbar different objects could be inserted, constructions could be made in the Graphics View as well as in the 3D Graphic View window. The toolbar is changing depending on which window the construction is made in. The option of already constructed objects or elements of the figure to be removed shows the construction in a more informative and understandable way.*

Key words: *GeoGebra, geometric figure, area, edge, construction, object, toolbar.*

INTRODUCTION

The interactive mathematics software GeoGebra allows constructing points, lines, segments, angles, triangles, polygons, circles, graphs of functions, embedding electronic tables, etc. The range of tools which the software offers is intuitive and easy to orient in for teachers and students. The animation in GeoGebra is not only an entertaining element of constructing but also a functional instrument for visualization of the figure. Different colours for already constructed figure could be chosen, different colouring could be used for already constructed objects and their elements. Doing so pupils' attention and thinking could be directed to desired aim of teaching. Settings of the Graphics View, using dynamic colours, inserting dynamic text, tools manipulating are also a little part of the mathematics software options. In this paper we will outline and analyze the stages and features of constructing two geometric figures: right pyramid and right prism together with inserting dynamic text for finding the volume of already constructed prism.

EXPOSITION

GeoGebra is easily accessible interactive mathematics software which can be rapidly downloaded and installed. After running the software two windows are open: algebraic one and a Graphics View. In the algebraic window the coordinates of points, lines, segments, polygons and all the constructed objects are displayed. Within the Graphics View the constructed figures are represented (Dimkova, D., 2012). By using the toolbar there is a possibility to show or remove (hide) the axis, to choose the colours of objects, to show or hide the names, symbols and/or the values of the construction's objects. This is of great help when preparing the Graphics View for a more effective way to work in it.

Let's consider two problems for constructing a right pyramid and a right prism in GeoGebra.

Problem 1. Construct a right pyramid in GeoGebra.

In order to construct a right pyramid we should find and insert “Regular polygon” (for a base of the pyramid) from the toolbar and via click on the Graphics View to choose two points (Fig. 1). After placing the second point a new window with automatically appeared number is open and we choose the number of vertices of the pyramid in it. The appearing number here is just an optional one and we are not obliged to choose exactly this one but to enter manually the number of vertices (Fig. 2).

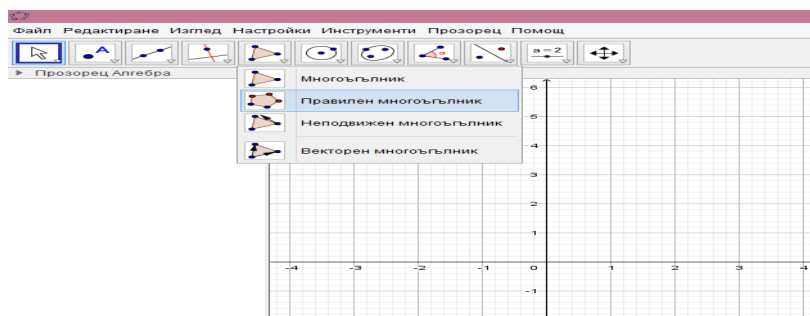


Fig. 1. Choosing and inserting an object “Regular polygon” from the toolbar

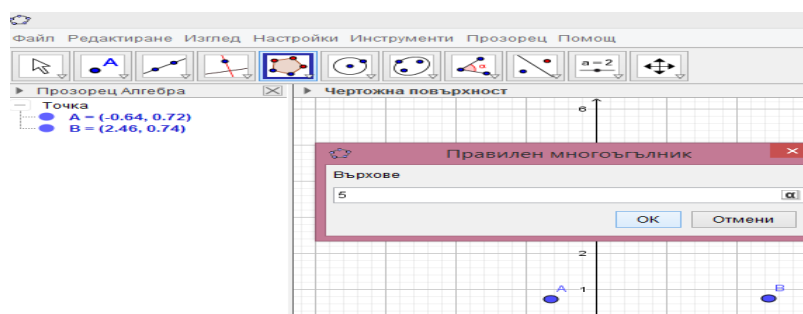


Fig 2. Choosing the number of vertices of the pyramid’s base

After the polygon is constructed we could see that in the algebraic window all the entered elements as well as their coordinates are given (Fig. 3). The polygon with the chosen number of vertices is constructed and we can move it within the Graphics View via mouse and at the same time to observe the dynamic change of the coordinates in the algebraic window.

The next step is to choose from the toolbar points for a midpoint of a segment or a center of a central symmetry (Fig. 4). We choose three points and three segments (sides of the polygon) and again we choose segments from the toolbar to connect the points with the opposite vertices of the polygon (Fig. 5).

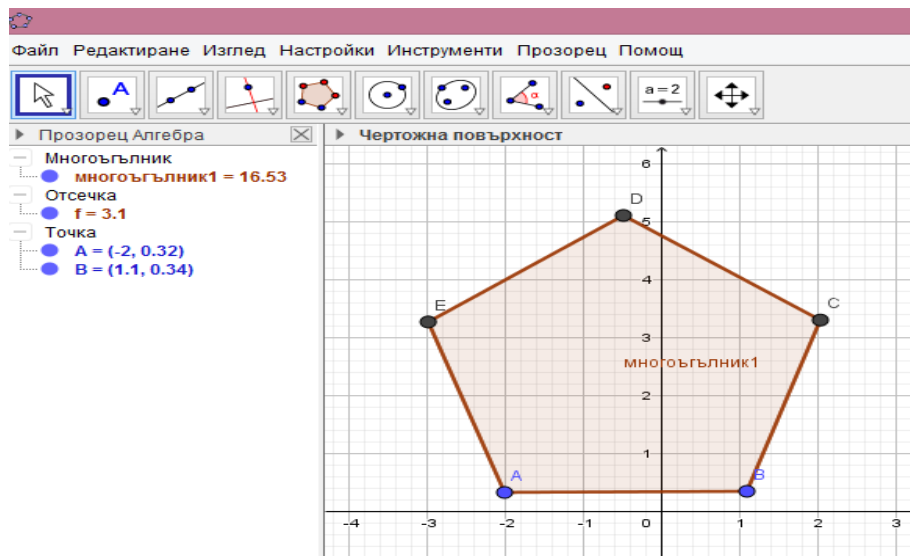


Fig. 3. The constructed polygon – base of the pyramid

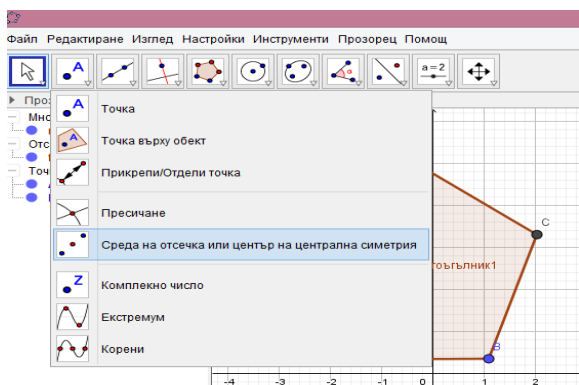


Fig. 4. Choosing a segment or a centre of a central symmetry

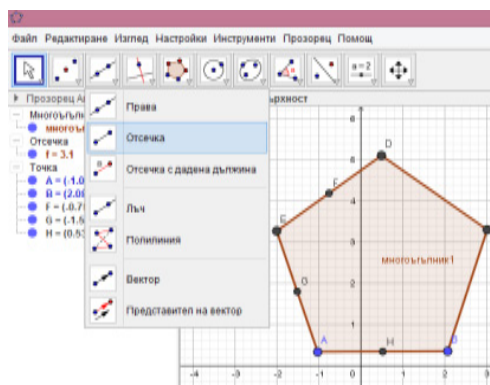


Fig 5. The chosen object from the toolbar could be multiply used

From the toolbar we choose the point of intersection of the constructed objects (Fig. 6). We can open a new window with 3D Graphic View in which the constructed polygon is displayed (Fig. 7). For a more clear and understandable image the axes could be removed (Fig. 8).

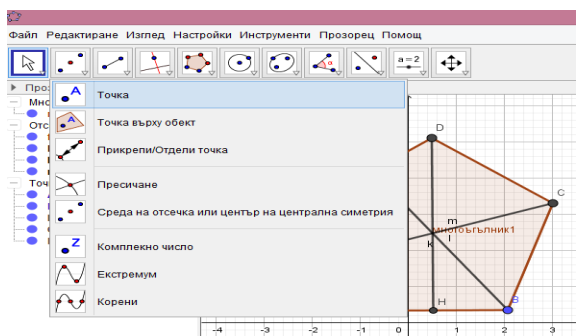


Fig. 6. Denoting the center of the polygon with a point

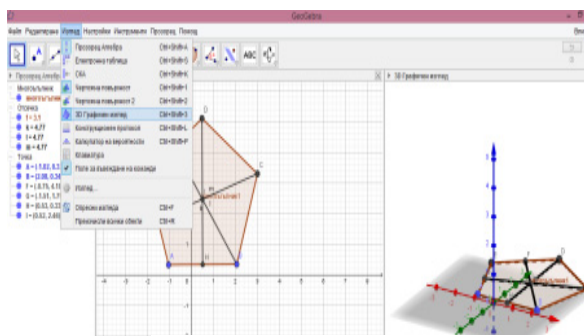


Fig. 7. 3D graphic view of the figure

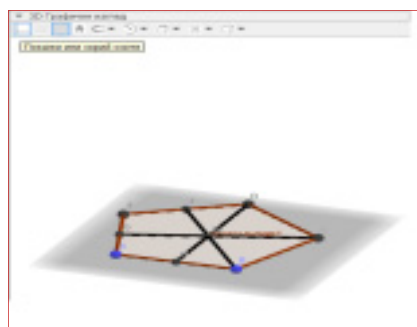


Fig. 8. The polygon is in 3D Graphic View with coordinate axes removed

Via one click on the blue points next to the objects in the algebraic window we hide the elements of the construction which are not needed at the moment. When we are in the 3D Graphic View window the main toolbar is changing. From the toolbar we choose “Perpendicular line” such that to pass through the intersecting point of the hidden segments. On the constructed perpendicular line we choose a point which is to be a vertex of the pyramid and from the toolbar we choose “Pyramid” (Fig. 9).

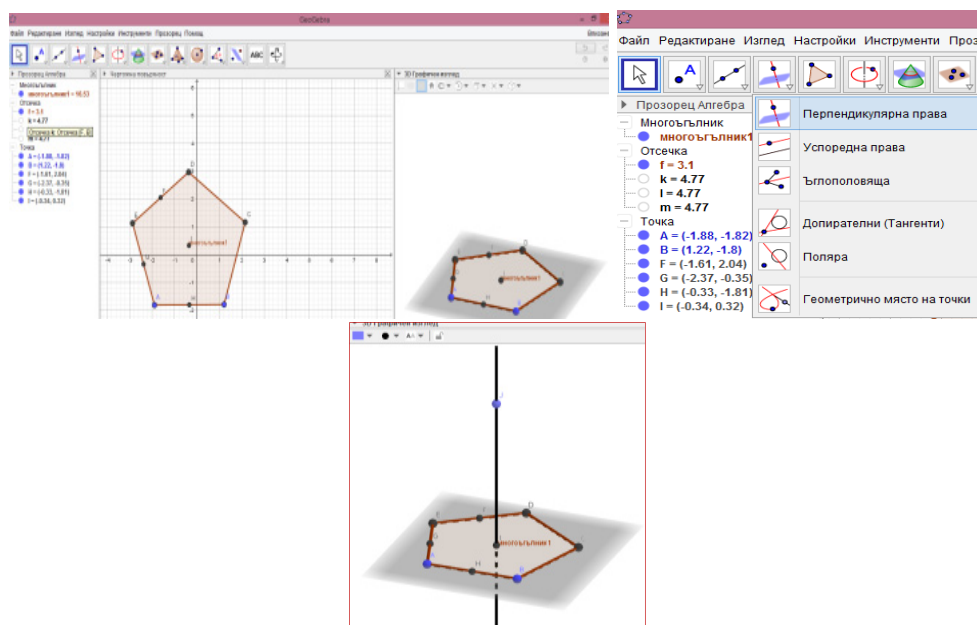


Fig. 9. Constructing a perpendicular to the base

Via one click on the base we construct the pyramid with a vertex – the chosen point of the perpendicular.

In order to achieve better visual image of the pyramid we could change the colours of the pyramid's elements from the 3D Graphic View window's toolbar and again to hide all the elements not needed at the moment (Fig. 10).

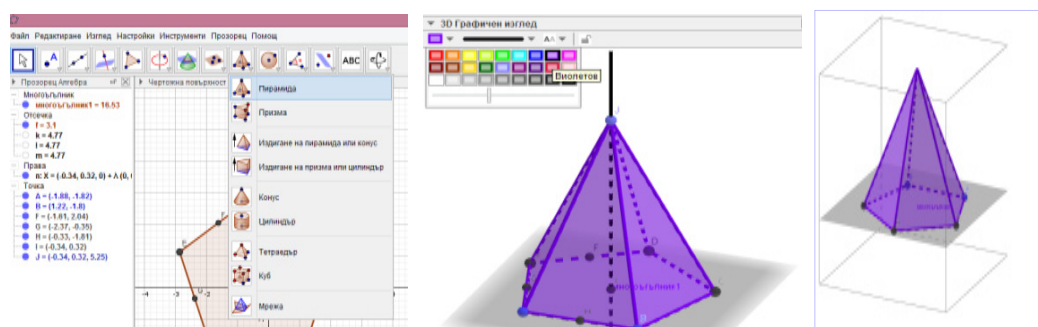


Fig. 10. The pyramid shown by rotation in different positions

Problem 2. Construct right prism in GeoGebra and find its volume by inserting dynamic text.

In order to construct right prism we choose “Polygon” from the toolbar and connect three points in the Graphics View. Doing this in the Graphics View, a triangle ABC is displayed and its elements as well as their coordinates are given in the algebraic window. We open again the 3D Graphics View window and choose “Perpendicular line” from the toolbar (Fig. 11).

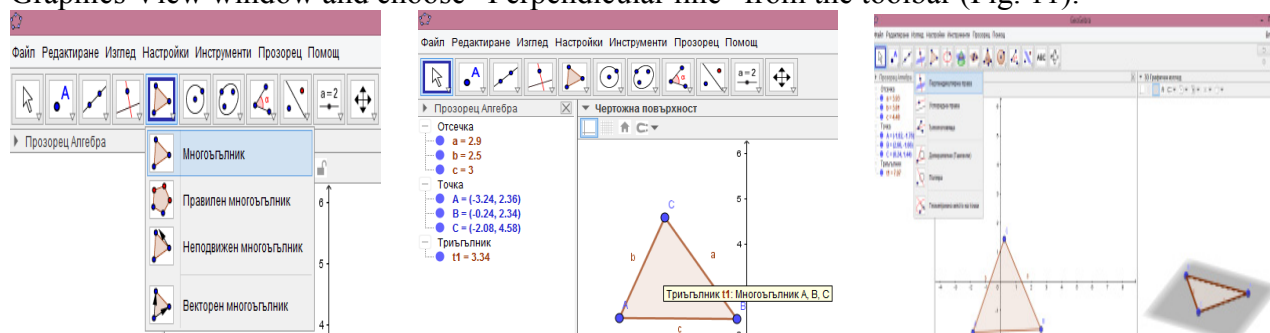


Fig. 11. Steps of constructing the prism's base

We choose a point which is an intersection point of the base and its perpendicular line. Then on a random place on the perpendicular we choose a point to be a vertex of the top base of the prism. We choose “Right prism” from the toolbar and via click on the base in the 3D Graphics View window construct the perpendicular line to the point D (a random point on the perpendicular line). The main toolbar is changing dynamically depending on which window the construction is made in. First the window is chosen and then are the objects from the toolbar (Fig. 12).

In order to find the volume of the prism we will find the base's area first. The altitude of the triangle ABC can be constructed if a perpendicular line from the point C to the opposite side AB is chosen and constructed in the Graphics View. We construct the intersecting point of the perpendicular line and the side AB and from the toolbar choose the object “Segment”. We construct the segment – altitude from the vertex C to the intersecting point with the base and hide the perpendicular line from the Graphics View. We will use the side and the corresponding altitude to find the area of the triangle ABC . The perpendicular line is hidden in the Graphics View but can be seen in the algebraic window. The objects could be made stand out by using different colours, naming or denoting them as well as giving them a value or changing their name from the toolbar in the Graphics View (Fig. 13).

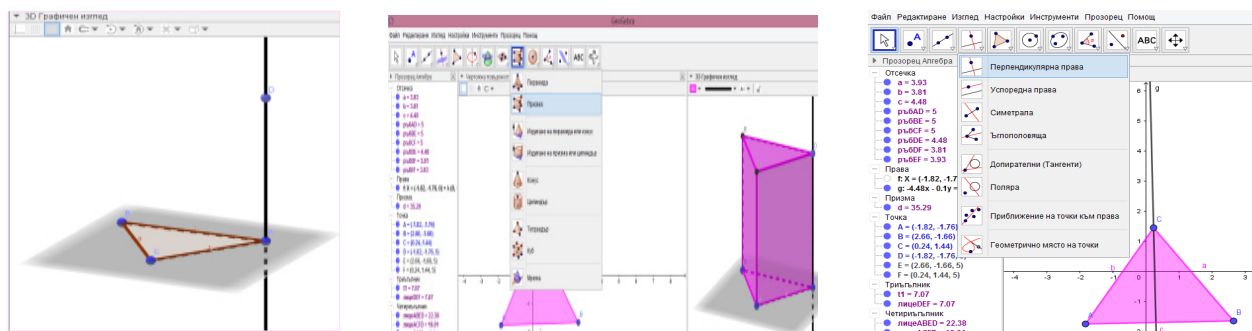


Fig. 12. Steps of constructing the prism

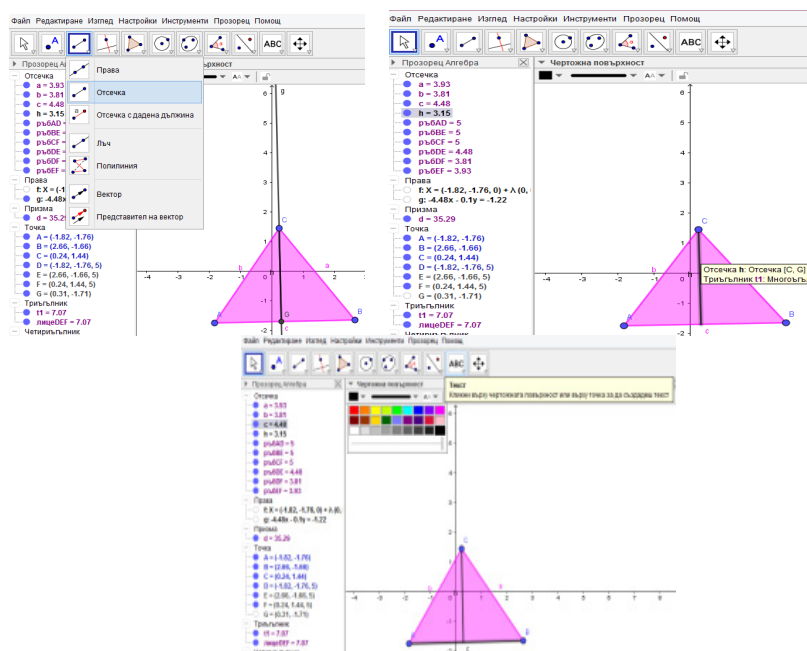


Fig. 13. Making the constructed objects stand out

From the toolbar a piece of text is chosen and via click on the Graphics View a window is open to input data in. we make a tick in LaTeX formula to have better preview and from the LaTeX formula toolbar input a fraction. In the “Editing” field the objects and their values to obtain the area

are entered. The space is used instead of a multiplication sign. When all the data is entered we choose and a dynamic text appears in the Graphics View. The same way by using the formula for finding volume and entering dynamic text the volume of the right prism is obtained. Changing the lengths of the base's edges leads to changing the calculations and the result – the area and the volume – in the dynamic text (Fig. 14). The placing of the dynamic text within the Graphics View could be changed too. When the problem is already solved we could view it in all three windows or in each of them. The software allows easy and likeable analysis of the problem and its solution by showing successively each step of the solution in all the windows (Fig. 15).

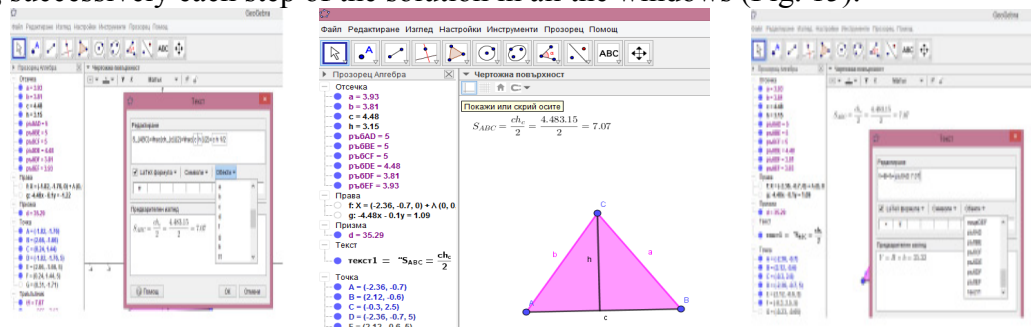


Fig. 14. Finding the volume of the prism

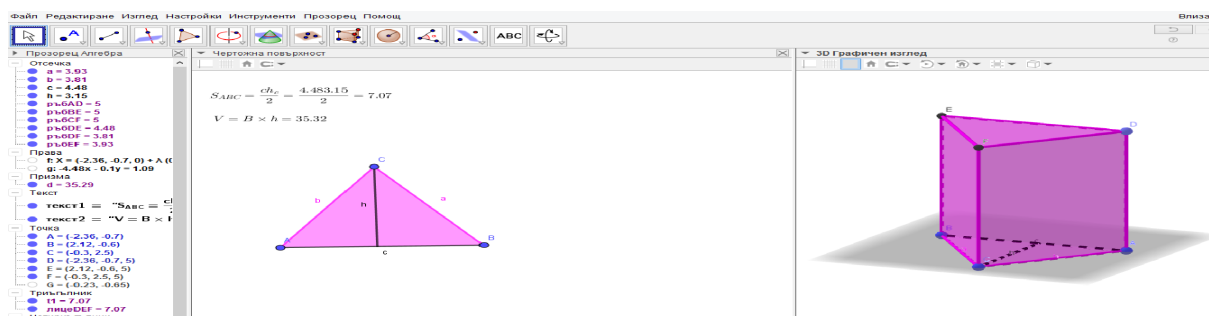


Fig. 15. Viewing the prism in all three windows

CONCLUSIONS

GeoGebra allows to make all elementary and basic geometric constructions and providing better understanding and enhancing the knowledge and ideas which are part of teaching and learning Stereometry and solving stereometric problems. Using GeoGebra in mathematics teaching to easier and more visualized notions, properties, statements, problems – basic to teaching geometry. Expected results after using GeoGebra as an instrument of teaching mathematics are increasing the students' interest in education and science as well as understanding and better motivation while assimilating mathematics.

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