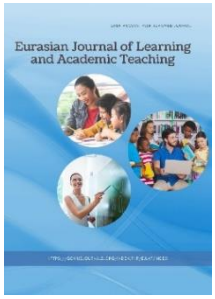

Using GeoGebra (3D With Jogl2) In Geometric Constructions

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ABSTRACT

Construction problems have always been an important part in learning Geometry. The following article is a new way to use technology to create geometric constructions instead of using an old-school ruler and compass. This will help teachers incorporate technology in the classroom and save time and materials in the process.

Keywords: Software, Window Program, Coordinate, Axes, Segment, Tools Line, Radius, Cylinder.

Introduction

Geometric construction has always been a fascination to many mathematicians and educators. While restricting the tools to straight edge and compass is not practical for real life construction, studies show that the exercises help students think logically. Furthermore, geometric construction reflects the axiomatic system of Euclidean geometry. There is a rich supply of construction problems that can be analyzed from various old and new sources. In analyzing why certain constructions work, the students will be able to visualize how certain properties and formulas work.

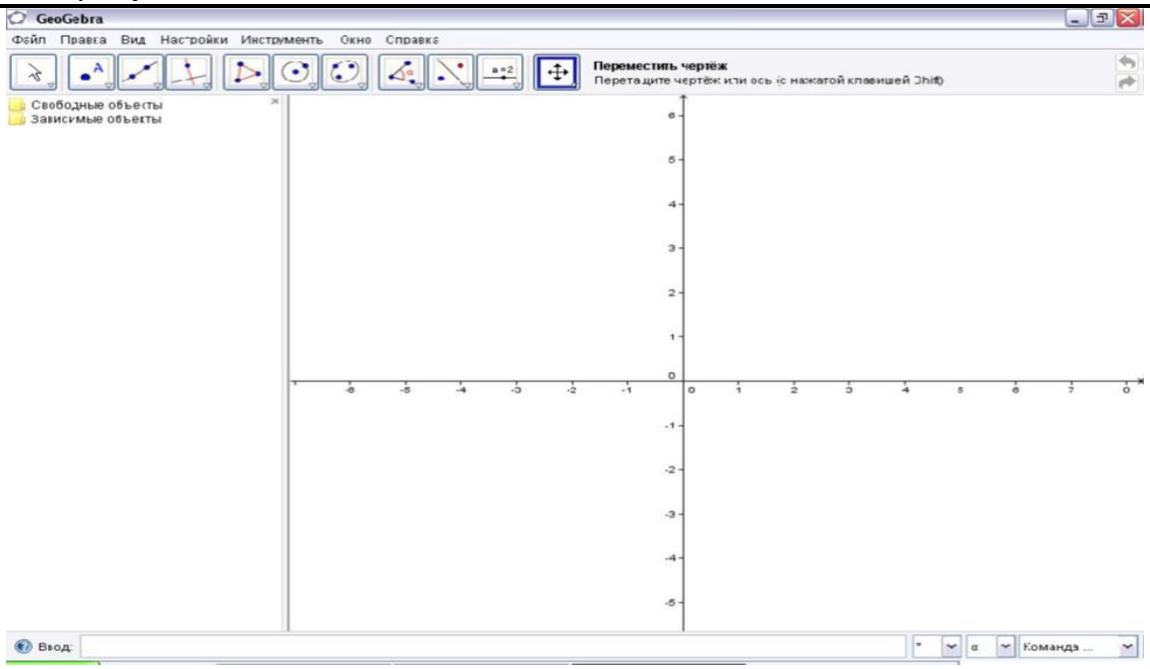
In solving the various construction problems, we will make use of the software GeoGebra. Many recent papers on Geometric construction, such as, make use of dynamic geometry software. In particular, GeoGebra came out in 2002 as a free dynamic geometry software, with comparable functionalities as other proprietary software. Currently GeoGebra is at version 4.4, with version 5 at the beta release.

GeoGebra 3D is a free educational mathematics program, combining geometry, algebra and calculus. GeoGebra 3D – freely distributed (GPL) dynamic geometric environment that makes it possible to create "living drawings" in planimetry, stereometry, in particular, for constructions using compass and ruler. In addition, the program has rich capabilities for working with functions (building graphs, calculating roots, extrema, integrals, etc.) due to the commands of the built-in language (which, by the way, allows you to control geometric constructions). The program is written by Markus Hohenwarter in Java (so slow, but on most operating systems). Translated into 39 languages. Fully supports Russian language.

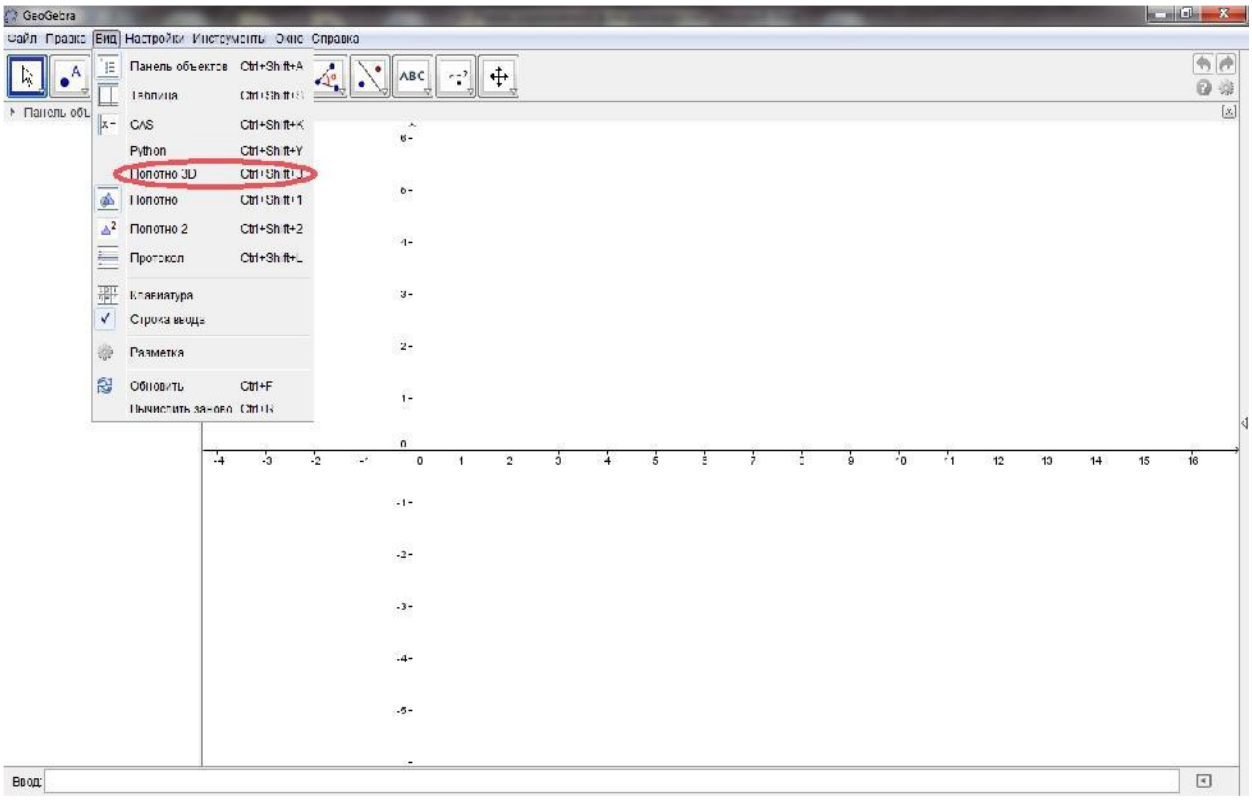
Methods

This article discusses working with the Russian version of the environment GeoGebra (3DwithJOGL2).

While opening the program, window looks like the one shown in Figure 1.



In addition to the menu bar familiar to most programs, in the window programs are located **Панель инструментов** (1), **Панель объектов** (2), **Область геометрических построений** (3) and **Строка ввода** (4). To open 3D canvases, you need to go to the View tab in the menu bar. With a light click on the tab, the 3D GeoGebra Canvas turns into 3D Constructor (Figure 2 and 3) Figure 2



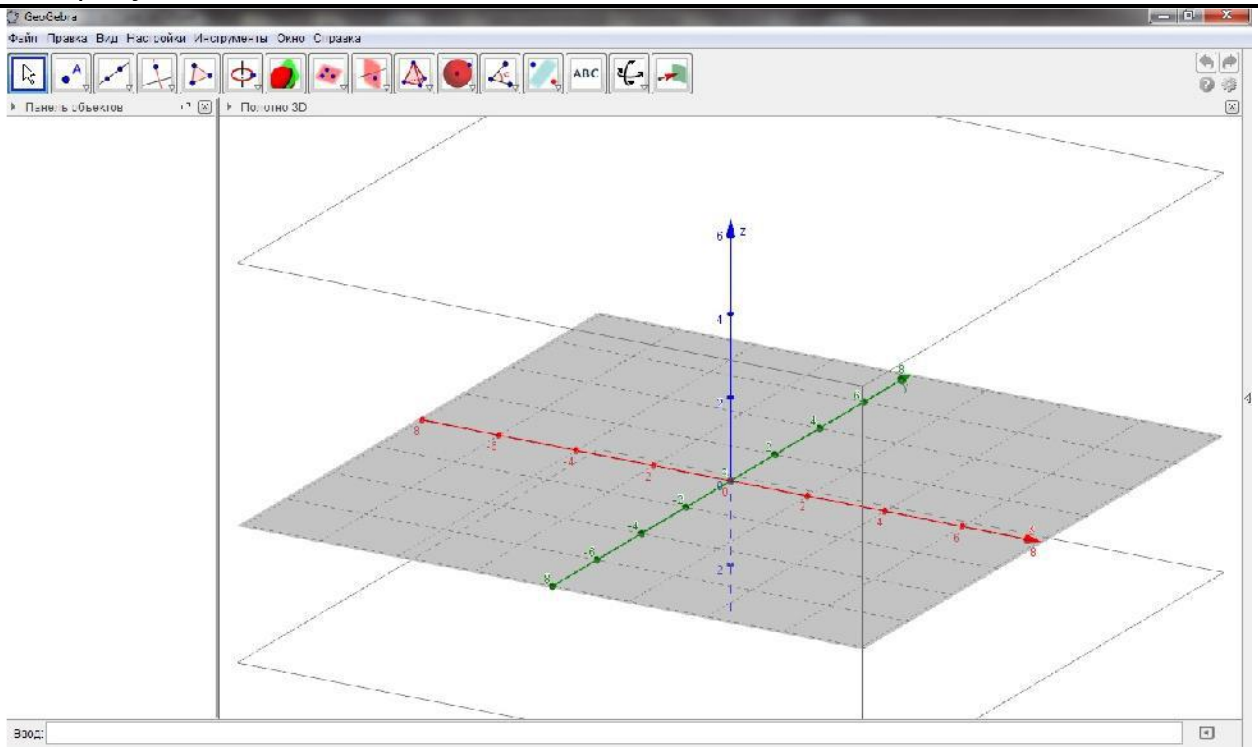


Figure 3

The position of free objects can be changed arbitrarily, whereas the position of dependent objects changes only in accordance with changes free.

Строка ввода line consists of two parts: the line itself **Строка ввода**, as well as the **Список команд**- a drop-down menu in which you can select a command to enter from the list. You can display the **Список команд** disable in the **Вид** menu.

Display of the **Панели объектов**, **Строки ввода** lines can be disabled in the menu **Вид**. In the same menu you can enable the display of another window element programs - **Таблицы**. Also in the **Вид** menu you can enable display on **Панели объектов** are another type of object – auxiliary.

RESULTS

While running GeoGebra in the Geometry area coordinate axes are drawn. You can also, if desired, use command **Вид – Сетка** to set the drawing of a coordinate grid. For more detailed settings of the workspace, you can run the command **Настройки – Полотно**.

Here, on the Axes and Grid tabs, you can set the color of objects, methods styles. For axes, you can specify their designation and unit measurements, etc.

The **Панели инструментов** contains various tools for geometric constructions, divided into groups, as evidenced by a small triangle in the lower right corner of each button on the panel. When you click on it, a drop-down menu opens from which you can select the desired tool. When constructing various geometric objects, information about them is automatically entered into the list on the **Панели объектов**, and the objects themselves are displayed in the **Области геометрических построений.**

All objects are divided into free and dependent. To the free include all independent objects, that is, built arbitrarily in construction areas. Dependent objects are built based on already available free or dependent objects.

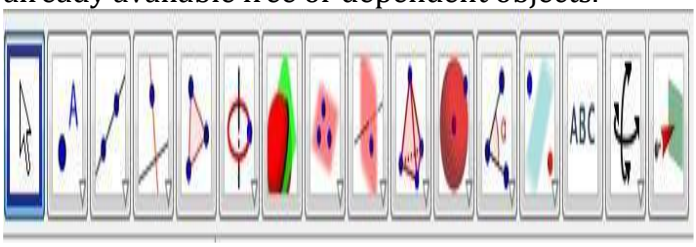


Figure 4

The Panel is used to build various **Панель инструментов**, the instruments on which are divided into groups. Let's consider consistently available tools to the user (Fig. 4).

Using the **Перемещать** tool (Fig. 5), you can select objects (groups of objects) and

change their position on the coordinate plane. For in order to select several objects at once, you need to hold down the keys **Ctrl** sequentially point to them with the mouse.

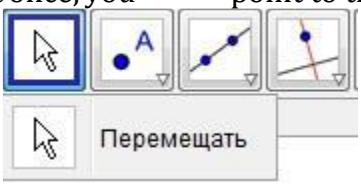
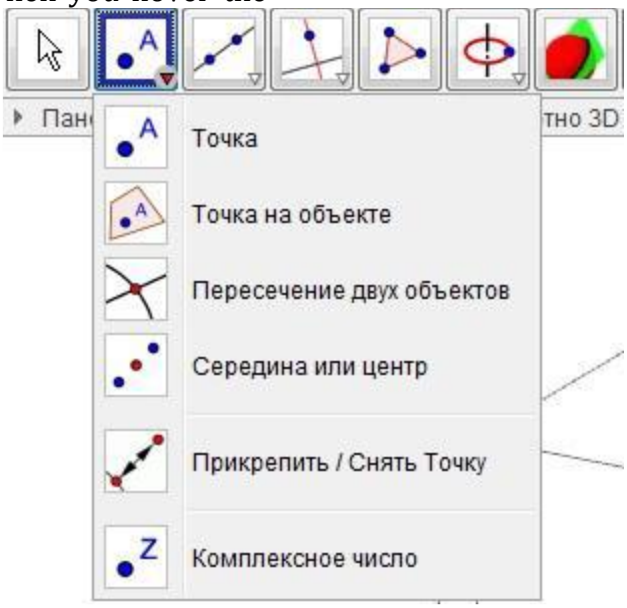


Figure 5

To construct a point, you need to select the **Точка** tool (Fig. 6) and specify place on a plane. The default point is indicated by a capital letter of the Latin alphabet and on the plane is given by a pair of coordinates. When you hover the mouse cursor over the construction area, it takes the form of a cross, near which the current coordinates are displayed. Default point has a blue color.



Picture 6

To construct a point on any object, use the function **Точка на объекте** (Figure 6). When choosing this element, you need to remember that the point can only be placed on the site, it will not be able to leave the borders objects. It is possible to move a point inside an object. Such a point turns blue.

To construct points that are the intersection of two objects, you can use the **Пересечение двух объектов** tool (Fig. 6). By choosing this tool, you need to specify two objects whose intersection points you need build. Such points will be colored gray and will be dependent objects.

To construct the middle of a segment, you need to select the **Середина** tool or **центр** (Fig. 6) and indicate either two points - the ends of the segment, or a segment, the middle of which needs to be built. Using the same tool, you can construct the center of a geometric figure, such as an ellipse.

In order to attach or remove an attached point there is function **Прикрепить /Снять точку** (Figure 6).

The **Комплексное число** function (Figure 6) allows you to insert a point on selected plane. The dot turns blue.

Tools Line by two points, **Line by two points**, **Ray from two points**, **Vector from two points** (Fig. 7) construct a straight line, a segment, ray and vector, respectively, pointing to two points, through which the desired line passes through. You can select points that are already are on the drawing, or indicate with the mouse where these will be located points.

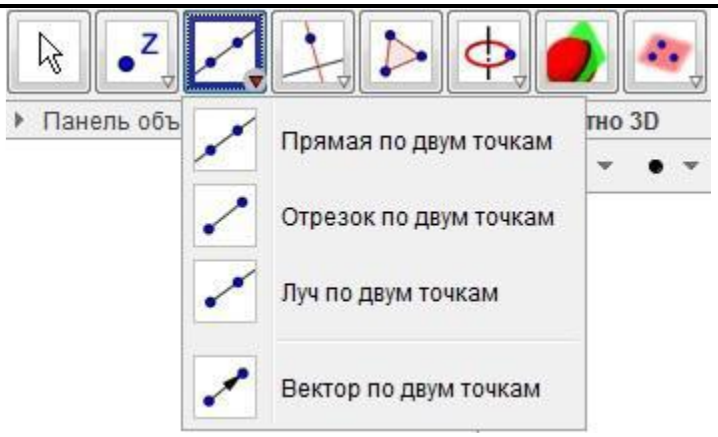


Figure 7

To construct a line perpendicular to a given one, you need to select **Перпендикулярная прямая** tool (Fig. 8), point the straight line to plane, perpendicular to which will be constructed, as well as the point through which the new line will pass. The same way a straight line parallel to the given one is constructed using a tool **Параллельная прямая**.

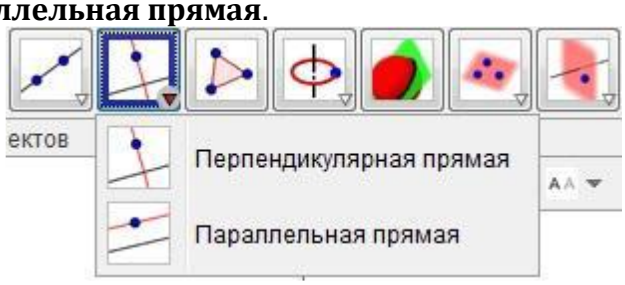


Figure 8

To construct an arbitrary polygon, use **Многоугольник** tool (Fig. 9). To build a figure using it you need to sequentially specify all the vertices of the polygon, and then point to the top from which the construction began.

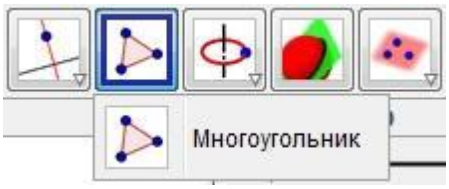


Figure 9

There are several options for constructing a circle. For example, function **Окружность по точке и оси** (Fig. 10) allows you to construct a circle in the desired axis, but with an unknown radius, that is, an arbitrary circle. The second function of this subgroup is a **Окружность с центром, радиусом и направлением** (Fig. 10) makes it possible to construct a circle with fixed center, direction and with a given center. So to use this function, you need to point with the mouse where you should be the center, then the direction of the radius and lastly enter the size radius. The last function of this subgroup makes it possible constructing a circle using three points on any axis surface. This function is called **Окружность по трем точкам** (Fig. 10).

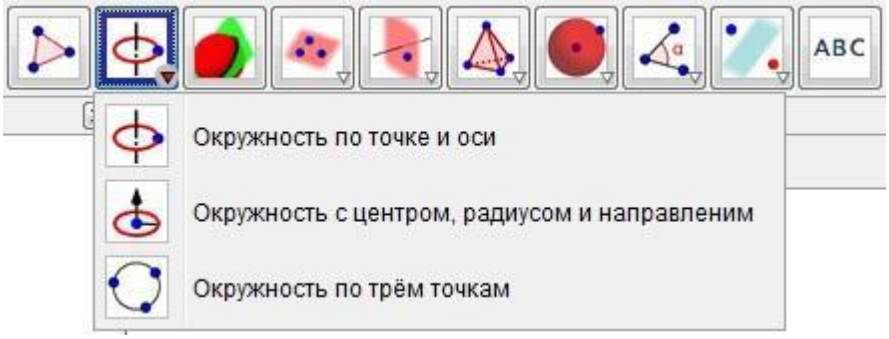


Figure 10

This subgroup of functions makes it possible to construct planes. The **Плоскость через три точки** function (Fig. 11) allows you to construct plane on any axis through any three points. The plane is colored in grey color. **Plane** (Figure 11).

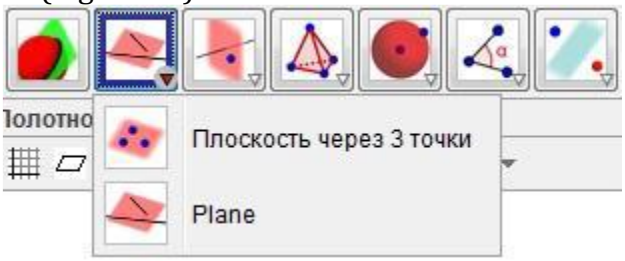


Figure 11

Перпендикулярная плоскость, Параллельная плоскость. Data functions allow you to construct perpendicular and parallel planes respectively. To construct a perpendicular plane, select point with the mouse and a line perpendicular to this point. Plane is built automatically. To construct a parallel plane, select a point and a parallel plane, the rest of the steps are the same as when constructing a perpendicular plane (Fig. 12).

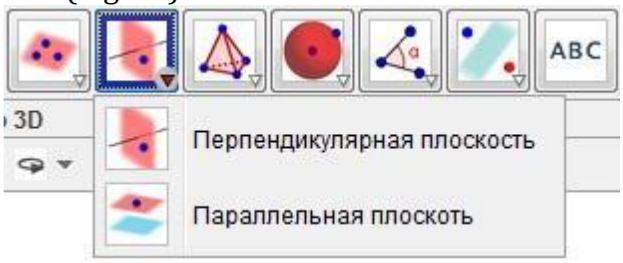


Figure 12

The most important figures in geometry are the pyramid and the prism. therefore, this subgroup of functions is specifically for these figures. Functions of Pyramid and Prism allow you to build these figures through any points and in any plane of the coordinate axis (Fig. 13).

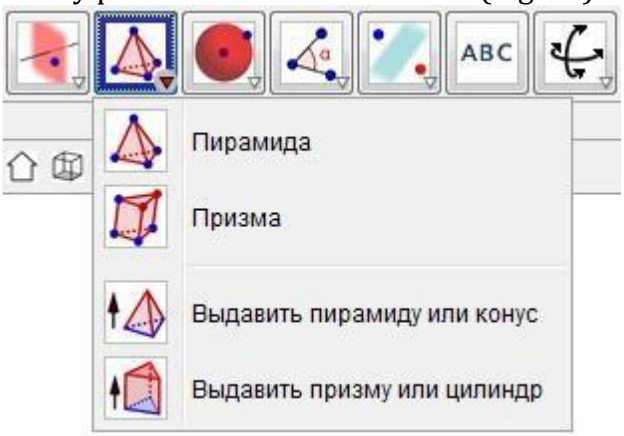


Figure 13

Using the Extrude Pyramid or Cone and Extrude Prism functions or a cylinder (Fig. 13), the construction possibilities double. The last subgroup of functions that I want to introduce are functions **Sphere by Point and Center**, **Sphere by Center and Radius**, **Cone and Cylinder** (Figure 14). As can be seen from the names, this subgroup specializes in the structure of spherical figures.

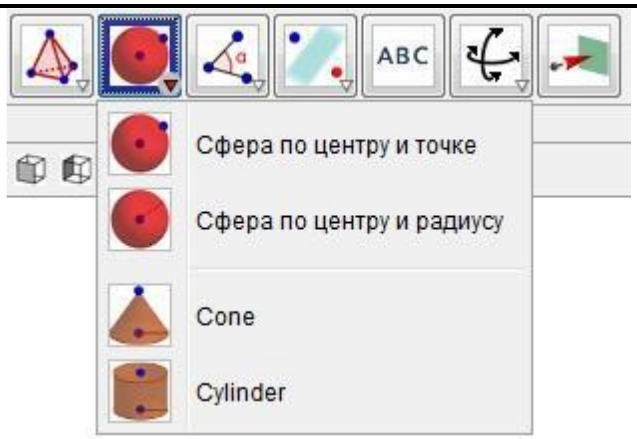


Figure 14

Conclusion

The GeoGebra3D software environment can be quickly mastered by people having basic computer skills, which is undoubtedly is a big advantage of this software product. One argument in favor of GeoGebra 3D is its simplicity integration with office applications - all drawings can easily be done via clipboard be transferred for future use as in text editors that support working with images and graphic editor.

Used Literature:

1. Haftamu M. G., "Revisiting Geometric Construction using Geogebra", The Research Journal of Mathematics and Technology, Volume 5, Number 1, ISSN 2163-0380 https://www.researchgate.net/publication/303403663
2. Shigapov, "Методическое пособие по GeoGebra 3D: построение 3D графиков", Kazan-2014 https://kpfu.ru/portal/docs/F487527991/Shigapov.pdf
3. https://www.geogebra.org/m/DPhxbF7X