International Journal of Management, Sciences, Innovation, and Technology

Research Casestudy

Vol.2, Issue.1, pp.15-26, Jan (2021) **ISSN:** 0000-0000

Application of Geogebra In Mathmatics Teaching

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Available online at: https://ijmsit.com/volume-2-issue-1

Received: 17 Nov 2020 Revised: 21 Nov., 2020 Accepted: 27 Dec, 2020

Abstract— Mathematical education software is designed for innovative, interactive and dynamic teaching in various areas of mathematics. Their application would be best in distance education, which implies the spatial distance between teachers and students. In this paper, the focus will be on GeoGebra, software that mathematically connects geometry, algebra and analysis. The method of software application and integration with the Moodle platform will be explained. Advantages of using it for students in the process of visual mastering of mathematical material. Increasing the interactivity between teachers and students, all with the aim of improving the quality of teaching. The work was created with the aim of popularizing the free GeoGebra software and the distance learning platform Moodle.

Keywords— GeoGebra, dynamic mathematics software, faculty mathematics, creative environment, didactic experiment, geometric concepts.

I. INTRODUCTION

GeoGebra is dynamic mathematics open source software for learning and teaching mathematics in schools. It was developed by Markus Hohenwarter and an international team of programmers[1]. They, followed by many other GeoGebra specialists, have done a brilliant work. Since the time that GeoGebra was introduced are done a great number of progressive steps by many mathematics teachers and lecturers throughout the world. GeoGebra combines geometry, algebra, statistics and calculus. GeoGebra provides the basic features of Computer Algebra System to bridge gaps between Geometry, Algebra and Calculus. The software links the geometric constructions shown in Geometry window to the analytic equations and coordinates representations and graphs shown in Algebra window.

The default GeoGebra view is consisted of the Algebra View, the Graphics View, the Input Bar, and the Tool Bar. There are two ways to construct an object in GeoGebra: use of the Tools in the Toolbar, or use of the corresponding Command entered in the Input Bar. In every case an object is constructed, its algebraic representation appears in Algebra View, whereas its geometrical representation appears in Graphic View. It is this dual representation of objects – visually in the Graphics View and Algebraically in the Algebra View –which makes GeoGebra so powerful.

We can do geometric constructions on the drawing pad of the graphics window and, on the other hand, we can directly enter algebraic input, commands, and functions into the Input field by using the keyboard. To do geometric constructions are used the main virtual tools, which are found in the set of the toolboxes that require from the user to open them, select, activate and use during the construction process. In the toolboxes are found the virtual tools with their names linked with their functions like: New point, Move, Line through two points, Segment between two points etc., alongside is their picture as well. There are also buttons like: Delete object, Move, drawing pad, Zoom in / Zoom out, Undo / Redo buttons etc… The number of commands that GeoGebra offers is greater than the number of geometry tools. GeoGebra environment is very pleasant and attractive because it has game features. The virtual tools of GeoGebra can be easily used and played with by anyone of the whole school system[2]. According to Hohenwarter and Preiner, GeoGebra appears to be friendly software that can be operated intuitively and does not require advanced skills to get started.

II. GEOGEBRA - A TOOL FOR DYNAMIC MATHEMATICS

GeoGebra was created with the goal of helping students better understand mathematics. Students can easily manipulate variables, simply drag "free" objects along the plane of the drawing, or use sliders [3]. Students use the technique of manipulating free objects to generate changes, and then notice how this reflects on the legality of the behavior of dependent objects. In that way, students were given the opportunity to solve and notice some problems through dynamic research of these mathematical relations. GeoGebra provides good opportunities for cooperative learning. Cooperative learning is a good choice of ways to work in many areas of mathematics. Classical lectures should be replaced by thematically oriented interactive ones. The primary role of the teacher is not to teach, explain or some other type of attempt to "transfer" mathematical knowledge, but to create situations that will enable students to "make" the necessary mental constructions faster. In this sense, GeoGebra provides multiple opportunities for cooperative learning, for example working in small groups, or interactive teaching for the whole class, or Individual/group presentations of students[4].

GeoGebra is a dynamic math software for use in elementary and high schools that combines geometry, algebra, analysis, table usage, and statistics. The name of the program is composed of parts of the words geometry and algebra. Its creator is Marcus Hohenwarter, but the further development of this software is the result of the joint work of hundreds of experts in computer science, mathematics and education involved in the work of the GeoGebra Institute around the world[5]. On the one hand, GeoGebra is DGS, which means that it allows the use of interactive geometry. In addition to the classic elements obtained by combinations and intersections of lines and circles, ellipses, hyperbolas and parabolas can also be drawn. On the other hand, GeoGebra allows direct entry of coordinates and equations that will be geometrically interpreted. It is possible to assign conic sections and lines to explicit and implicit equations, and lines can also be given parametrically. GeoGebra uses Cartesian and polar coordinates. Since this program uses work with numbers, angles, vectors, points, straight and conical sections, we can consider GeoGebra as one of the CAS. The numerical capabilities of this software also enable more diverse geometric commands: center of length, focus, vertices, main axes and diameter of conical sections, direction coefficients, direction vectors and normal line vectors, etc. Graphic, algebraic and tabular parts are interconnected and dynamic.

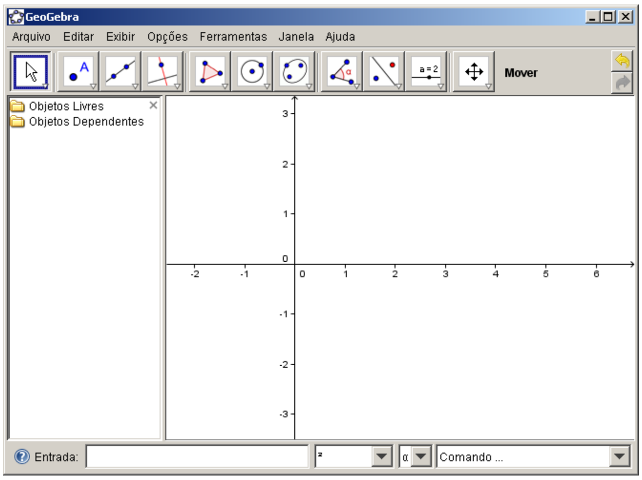


Figure 1. GeoGebra work environment

Communication between GeoGebra and the user takes place through an interface that, if necessary, can be presented in different forms - perspectives. The perspective whose two main parts are the algebraic and geometric window is the most suitable for displaying and learning analytical geometry in a plane. The algebra window shows the coordinates of the points, as well as the equations of the curves we work on, as well as all other numerical values (angles, lengths, areas, etc.). It can be visible or hidden. The geometric window is similar to other DGS[6]. The figures in it can be drawn directly, using the mouse or the input field. Later, these figures can be manipulated with a mouse or keyboard. Algebraic expressions that follow all changes in a geometric window can be seen in an algebraic window. The very purpose of this software - its use for educational purposes - has dictated the way in which data entry is determined. It is the input of data in natural notation, almost identical to the way of writing in a notebook or on the board, that attracts students and teachers and makes it much easier for them to work with GeoGebra[7].

GeoGebra is written in Java, which allows it to be used regardless of what is in use: Windows, Linux, MacOS or Unix. In addition, it can be launched through an Internet browser. Versions for iPad, Windows and Android tablets are also available. In October 2014, a version of GeoGebra for mobile phones was announced. If the program is installed on a computer, it can still be used regardless of whether the computer is currently connected to the Internet. GeoGebra allows you to directly print the resulting drawing, as well as display a dynamic drawing or description of the structure as a web page or drawing surface as images. Version GeoGebra 5 allows you to create new tools and manipulate the toolbar. A special advantage when creating worksheets for the presentation of teaching units is the conditional display of the text, which enables the display of parts of the material that the teacher wants to emphasize at a given moment. By the way, most of the geometric representations in this paper were done with the help of GeoGebra.

On the other hand, GeoGebra offers teachers significant opportunities to create interactive educational materials that can also be accessed online. GeoGebra stimulates teachers to use technologies in teaching, in the fields of: visualization of mathematics; "research" in mathematics; interactive classes via the site, or remotely; various forms of application of mathematics, etc.

III. USER INTERFACE AND BASIC COMMANDS

3.1. Multiplicity of representations of mathematical objects.

GeoGebra has three different ways of observing mathematical objects: a graphical representation, an algebraic representation, and a tabular representation. They allow mathematical objects to be represented in three different ways: graphically (e.g. point, graph function), algebraically (e.g. point coordinates, equations) or in table view cells [8]. All views of a single object are dynamically linked and will change automatically if you change any view, regardless of how the object was originally created [Ggb].

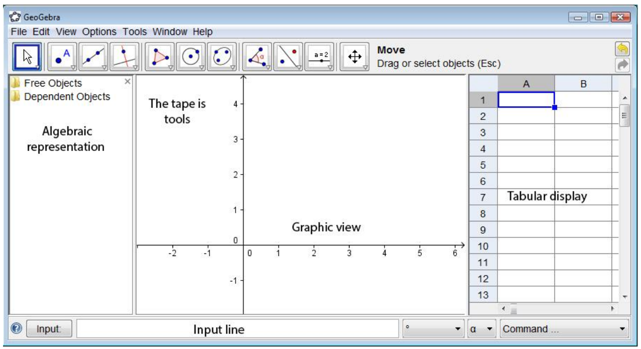


Figure 2. GeoGebra interface

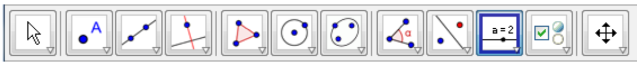
3.2. Graphic display

Using the construction tools available in the toolbar with the mouse, geometric constructions can be performed in a graphical representation. Select any construction tool from the toolbar and read the toolbar help (located next to it) to find out how the selected tool is used. Any object created in a graphical representation has its representation in an algebraic representation. Each icon in the toolbar represents a toolbox that contains similar construction tools. To open the toolbox, click the small arrow in the lower-right corner of the toolbar icon.

3.2.1. Getting to know the graphic display

The Graphics View always displays the graphical representation of objects created in GeoGebra. In addition, the Graphics View Toolbar is displayed at the top of the GeoGebra window, with the Undo / Redo buttons in the top right corner. The Graphics View is part of almost all Perspectives.

The purpose of this first activity is to practice using the Tool Bar and to get comfortable working with objects in the Graphics View.

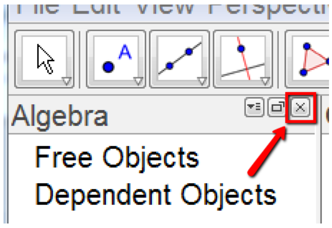


1. To begin with, hide the Algebra View. There are three ways you can do this:

• You can go to the View Menu → Algebra, or

• Ctrl + Shift + A or

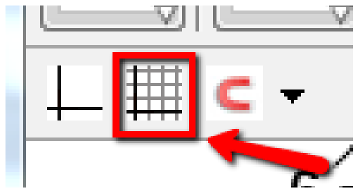
• You can click on the small icon in the upper right corner of the Algebra View Window.



2. Next, show the Coordinate Grid . There are two ways you can do this:

• You can go to the View Menu → Grid, or

• Now that the Algebra View is closed, you can click on the small grid icon in the upper left corner.



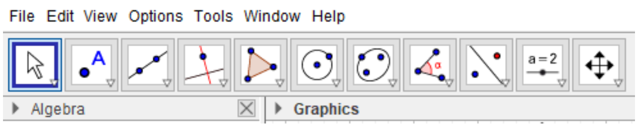
Note: The Tools of the Graphics View Toolbar are organized by the nature of resulting objects or the functionality of the Tools. You will find Tools that create different types of points in the Points Toolbox (default icon) and Tools that allow you to apply geometric transformations in the Transformations Toolbox (default icon).

3.3. Algebraic representation

Using the input bar, you can enter an algebraic expression directly in GeoGebra. When you press the Enter key, your algebraic entry appears in the algebra view, while the graphical view is automatically displayed in the graphical view. For example, entering a function: f (x) = x + 3 will write a function f in algebraic representation and display a graph of that function in graphical representation. In the algebraic representation, mathematical objects are organized as independent and dependent objects. If you create a new object without using one of the existing objects, it is classified as an independent object. If a new object is created using an existing object, it is classified as a dependent object. It is also possible to change an object in the algebra view: it is important that the Move tool is selected before double-clicking an independent object in the algebra view. In the input box that appears, you can directly change the algebraic representation of the objects. When you press the Enter key, the graphic display of the objects will change automatically. If you double-click a dependent object in the algebra view, a dialog box will appear that allows you to redefine the objects. GeoGebra offers a wide list of commands that can be entered into the input bar. You can open the list of commands in the right corner of the input bar by clicking the Commands drop-down menu. After selecting a command from the list (or typing the command directly into the input bar) you can press F1 to get information about how to use the command (syntax and command arguments).

3.3.1. Algebra Input Commands

By default, the Algebra View is opened next to the Graphics View. In addition, either the Input Bar is displayed at the bottom of the GeoGebra window (GeoGebra Desktop), or an Input Field is integrated directly in the Algebra View (GeoGebra Web and Tablet Apps). The Graphics View Toolbar is displayed at the top of the GeoGebra window, with the Undo / Redo buttons in the top right corner.
GeoGebra contains a set of internal commands and functions. These can be entered directly by using the box beside the word Input.
The Input bar is by default located in the bottom of GeoGebra window.
There are other commands available also that you can examine at your leisure in the GeoGebra help file. With these commands you can draw many types of graph that are not possible by just using the Geometry toolbar.



For example if you enter sin(x) into the Input bar and press the Enter/Return key you will find that the graph of sin x is drawn on the screen. The command Function[sin(x),0,2 pi] will draw the graph of sin x from 0 to 2π. Note the use of the square brackets and the space between the number 2 and the constant pi. We are now going to look at the ways that we can use direct input, entered into the Input bar, to perform many different constructions and operations.
3.4. Table view

In GeoGebra, each table view cell has a specific name, which allows each cell to be addressed directly. For example, the cell in column A and row 1 is called cell A1. The cell name can be used in expressions and commands to address the contents of the corresponding cell. You can enter not only numbers in cells, but all types of mathematical objects (for example, point coordinates, functions, commands). If possible, GeoGebra will display a graphical representation of that object immediately after entering the object. With such an entry, the name of the object will correspond to the name of the cell in which the object was originally created (eg A5, C1).

3.4.1. Graphics View Toolbar
The Graphics View Toolbar provides a wide range of Tools that allow you to create the graphical representations of objects directly in the Graphics View. Every icon in the Toolbar represents a Toolbox that contains a selection of related construction Tools. In order to open a Toolbox, you need to click on the corresponding default Tool shown in the Graphics View Toolbar (GeoGebra Web and Tablet Apps) or on the small arrow in the lower right corner of the Toolbar icon (GeoGebra Desktop).

Note: The *Tools* of the *Graphics View Toolbar* are organized by the nature of resulting objects or the functionality of the *Tools*. You will find *Tools* that create different types of points in the *Points Toolbox* (default icon) and *Tools* that allow you to apply geometric transformations in the *Transformations Toolbox* (default icon).

IV. GETTING STARTED WITH GEOGEBRO

There are two views shown by default when you start GeoGebra, the algebra view and the graphics view. In the upper right corner of each view there are icons to show the view in a new window or to close the view. You can find all views under the menu Views. The program has a user-friendly design which lets the user try it out by clicking on icons to create objects. Every object can also be created by writing a command in the input box.

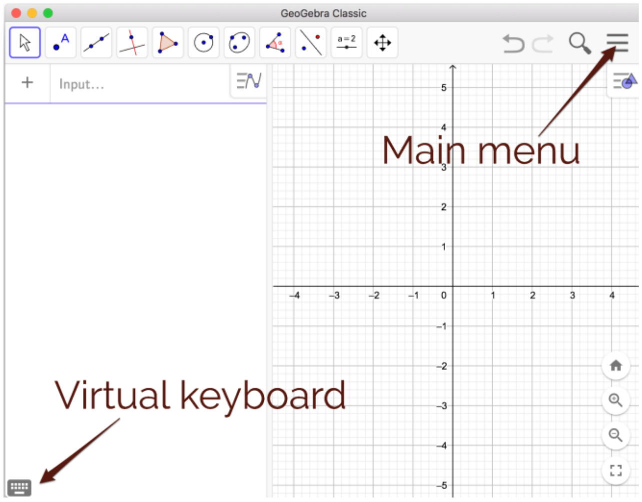


Figure 3. GeoGebra Classic

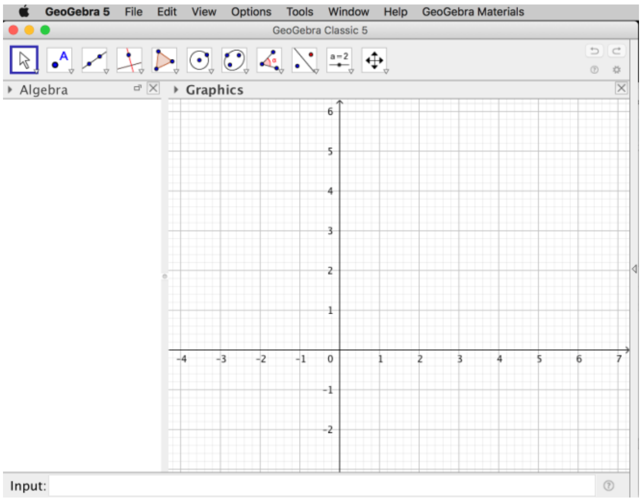
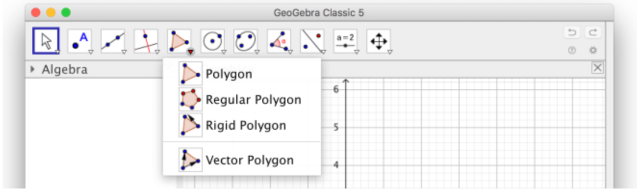


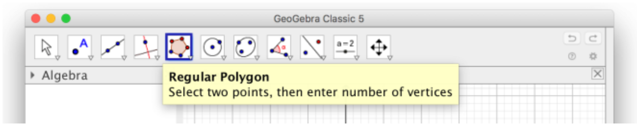
Figure 4. GeoGebra 5

4.1.1. The tool bar

Each icon in the toolbar will show a drop-down list of tools if you click on the small arrow in the lower right corner of the icon.



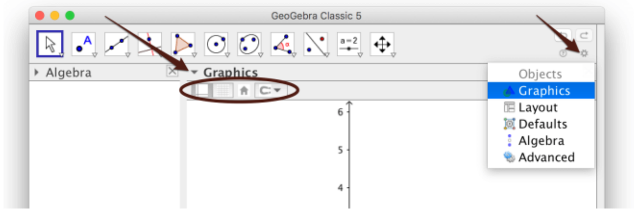
Each tool will let you enter an object in the graphics view, the toolbar help describes what is needed to make the object. If the toolbar help gives the hint to "select a point", you can either select an existing point by clicking on it, or click anywhere in the graphics view to make a new point. Some objects require other existing objects; as an example, you cannot make a parallel line if you don't already have a line in the graphics view.



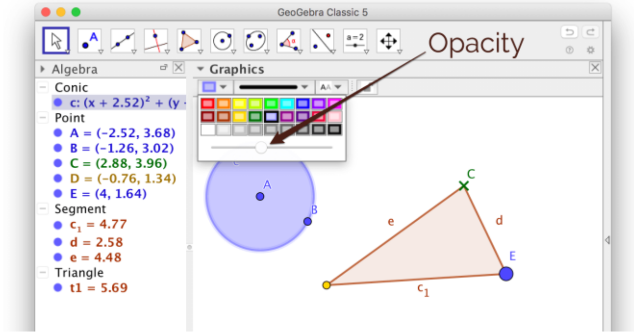
As long as a tool is selected in the toolbar, clicking in the graphics view will make a new object. Select the Move-tool to move an object (it takes a while for beginners to get used to this).

4.1.2. Properties

All objects have properties that you can change. The most common properties can be changed by using the styling bar. If no object is selected, the styling bar will show common properties for the graphics view. You toggle the styling bar by using the styling bar icon in the upper left corner of the graphics view. If you want to change the details of the coordinate system, click on the small wheel in the upper right corner and choose "Graphics". In the window that pops up, you find all the properties of the graphics view.



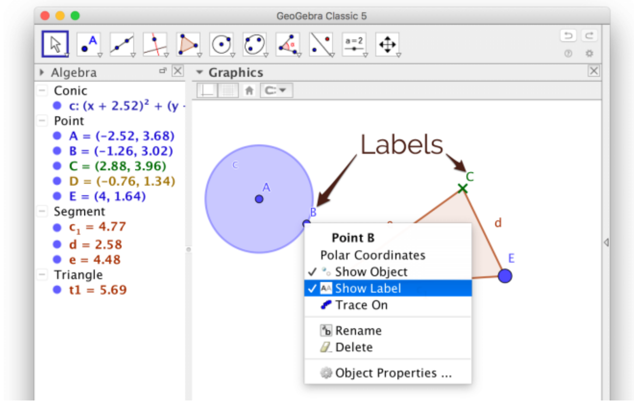
When an object is selected, the styling bar for that object will be shown. In order to change the styles of the points defining a circle, you must first select a point. Note that the opacity of circles is set to 0 by default, i.e. they are transparent. You can change the opacity in the styling bar.



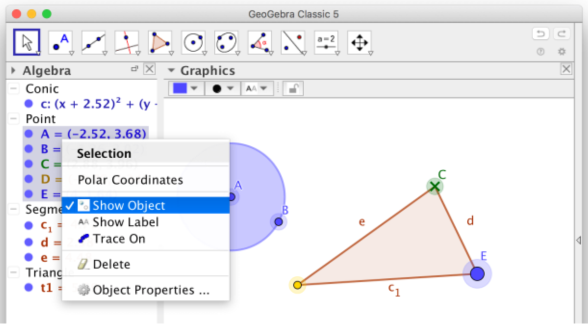
If you want to see all properties of an object, start by selecting it, then right-click and choose Object Properties; the Object Properties window will pop up.

Names and labels.

Each object in GeoGebra is given a name (you can name it yourself or change the given name). The names of all objects are shown in the algebra view. If the algebra is shown when creating an object, the label will be shown by default. If you don't want to show any labels, close the algebra view! After an object has been created you can choose to show or hide the label. Right-click on the object or use the styling bar.



4.1.4. Handle many objects
If you for instance want to hide all points, you can select all points by clicking on the heading Point in the algebra view. Then right-click on the selection and uncheck Show object.



You can also select many objects by holding down Shift while selecting objects in the algebra view.

4.2. Characteristics of GeoGebra
The main feature of GeoGebra is not to use it as a tool for making pictures, but rather to use it as a tool for making dynamic constructions. In order to learn GeoGebra however, it may be a good idea to start by making pictures.

Exercise 1

Create, change and delete objects
Check out how to create objects. Make sure you know how to create following objects:

- Circles in two different ways; use the tools **Circle with Center through Point** and **Circle with Center and Radius**.
- Polygons in two different ways; use the tools **Polygon** and **Regular Polygon**.
- Perpendicular and parallel lines.
- Reflections in lines.
- Intersection points.

Also make sure you know how to:

- change the appearance of the objects you created and how to move them around,
- change the appearance of the graphics view,
- show text in the graphics view.

Also try to:

- *regret* by clicking ctrl+z or cmd+z, or by using the icons in the upper right corner of the GeoGebra window, zoom in and out using the mouse wheel or trackpad.

4.3. Characteristic of dynamic (or interactive) geometry
The main feature of dynamic (or interactive) geometry is that you should be able change a geometrical object without changing the significant properties of the object.

If you draw a rectangle on a paper, your rectangle is merely one example of a rectangle. If you draw a rectangle in GeoGebra by placing four points, you can destroy the rectangle by dragging one of these points.

If you want to make a rectangle as a construction, you must consider the significant properties of a rectangle. When the construction is done, you should be able to drag some of the vertices to change the rectangle without destroying the properties of the rectangle; your construction should pass the dragging test.

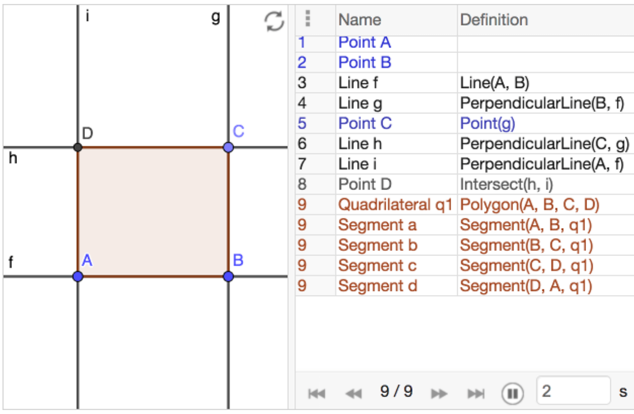


Figure 5. See all steps of the construction of a rectangle. Click on the play-icon.

4.3.1.Free and dependent objects

objects that depend on other objects. There is a difference between free and dependent objects.

Try out creating following objects:

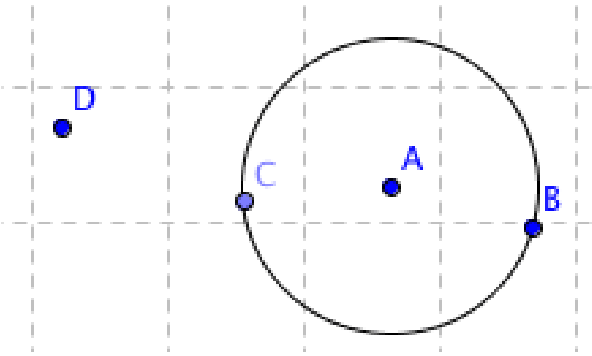


Figure 6. Object construction

- Make a circle using points *A* and *B*.
- Make a point *C* on the circle.
- Make a point *D* not on the circle.
- Move all points

You can move the point *D* freely. If you move *A* or *B* you change the circle, these points define the circle. The points *A* and *B* are free but the circle is a dependent object, it depends on the points.
If you move *C* it moves along the circle. *C* is defined to be a point on the circle and is hence dependent.
Observe the algebra view and choose **Sort by: Dependency**; the point *C* and the circle *c* are dependent objects.

4.3.2.Intersection points

An intersection point is a dependent object that depends on the two objects it intersects. Unlike a point on a circle, an intersection point cannot be moved at all and it is by default colored black. When making constructions keep an eye out on the color of the points. If an intended intersection point isn't black, you have failed intersecting two objects.

In most cases you can use the tool **Point** when making an intersection point. Sometimes, however, you want an intersection point where several objects intersect. In that case it may be easier to use the tool **Intersect**.

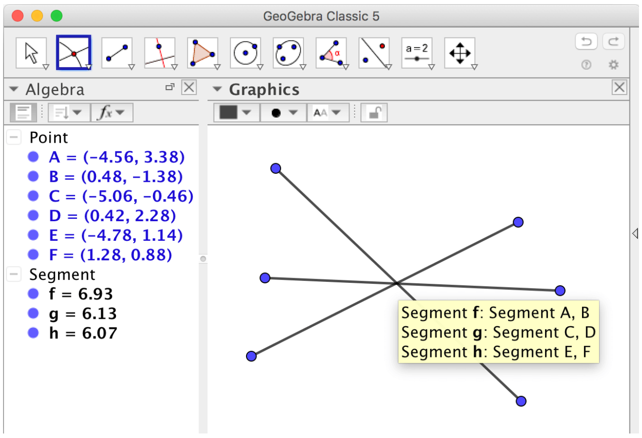


Figure 7. Display of the intersection point

If you, as in the picture, have three segments intersecting at approximately the same point, don't click on the intersection of the segments but click twice, first on one segments and then on the other using the **Intersect** tool. You can click on the segments either in the graphics view or the algebra view.

4.3.3. Ruler and compass

A geometric construction is often understood as a construction made using only a ruler and compass. Here we use the word construction as a construction you can make using all GeoGebra tools.

It is possible to use GeoGebra for classical ruler-and-compass-constructions. Choose Tools - > Customize toolbar to pick out the tools corresponding to a classical ruler and compass.

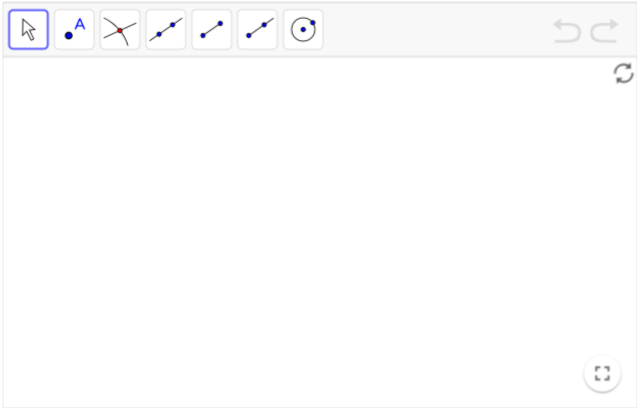


Figure 8. A customized tool bar for ruler and compass exercises.

4.3.4. Exercises

Exercise 1

Peaucellier-Lipkins linkage

The first mechanical linkage that transforms rotary motion into straight-line motion (and vice versa) is the Peaucellier-Lipkin linkage that was invented in 1864.

The linkage can be modelled using GeoGebra, such a model is shown below.

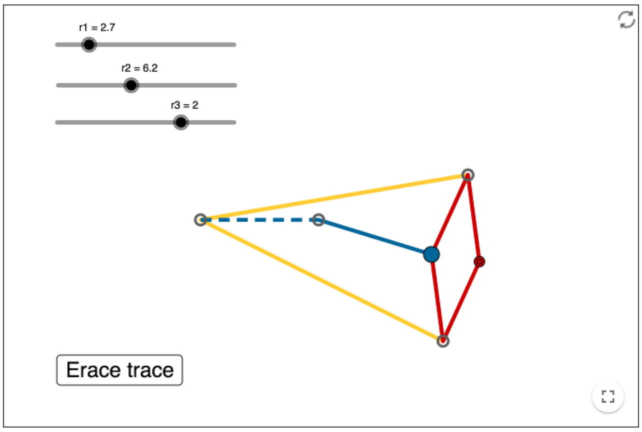
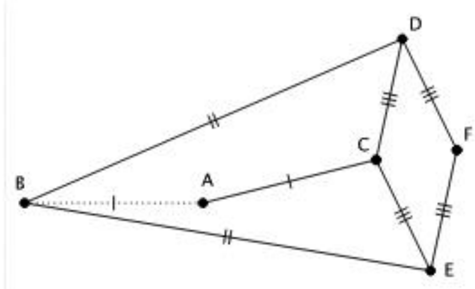


Figure 9. Drag the blue point.

In the figure below some points that are needed are shown. The point C should be draggable along a circular path. When dragging C the point F should move along a line.



There are three distances in the model that should not change when dragging CC. Following equalities must hold: AB = AC

BD = BE
CD = CE = DF = EF

Since these distances should not change, you should use the tool **Circle with Center and Radius**. The three radii needed can be represented by sliders.

Make an interactive GeoGebra model of the Peaucellier-Lipkin linkage by following these steps:

Step 1

Construct the three first points, the points called A,B,C in the figure. The points B and A must not move when you drag C.

Step 2

Construct the points called D and E in the figure. These two points have the same distance to C and the same distance to B. How to you make this happen?

Step 3

Construct the point called F in the figure. How do you do this and still maintain the equalities CD=CE=DF= EF?

Step 4

When your construction works you can show the rotary path and the straight-line path by letting the corresponding points show a trace. Right-click on a point and check Trace on.

V. PROOF OF THALES'S THEOREM ON THE PERFORMANCE ANGLE USING GEOGEBR

Before the construction itself, we will recall Thales' theorem on the circumferential angle and present its formal proof.
Theorem: Every circumferential angle over the diameter of a circle is a right angle.

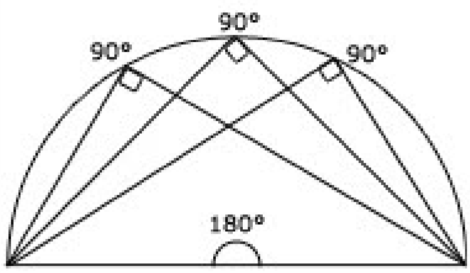


Figure 10. Construction of Thales' theorem

Proof: Let's look at the picture.

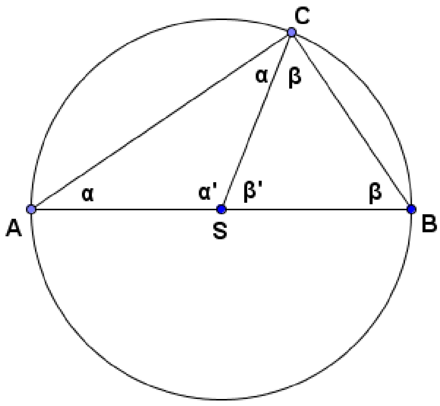


Figure 11. Proof of Thales' theorem

It should be proved that $\alpha + \beta = 90$ °. We see that the lengths AS, BS and CS are equal (because these are the radii of the circle). It follows that we have two isosceles triangles, ΔASC and ΔBCS. Therefore, the angles along vertices A and C are the same, ie the angles along vertices B and C are equal. Furthermore, it is also true that $\alpha' + \beta' = 180°$ (because these angles are complementary). In our proof we will also take advantage of the fact that the sum of the interior angles of a triangle is always 180 °.
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$2\alpha + \alpha' = 180°$ [2]
$2\beta + \beta' = 180°$ [3]

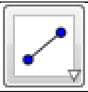
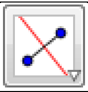
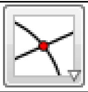
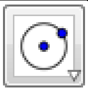
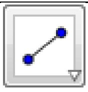
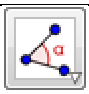
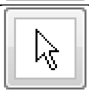
Adding [2] and [3] follows:
$2\alpha + 2\beta + \alpha' + \beta' = 360°$ [4]

$2\alpha + 2\beta + 180° = 360°$ [5]
$2\alpha + 2\beta = 180°$ [6]

After dividing equation [5] by 2 it follows as in the assumption:

$\alpha + \beta = 90°$ [7]

Such a formal proof of Thales' theorem would not be clear to all students, in fact only a few would understand it, and that is why this proof is processed in additional classes and with more advanced students. However, if we still want to convince students of the accuracy of Thales' theorem, we will use GeoGebra and its property of dynamism.

Tool selection	**Procedure**
	We draw an arbitrary length AB
	We draw a bisector over the length AB using a tool
	Determine the point S (intersection of the length AB and its bisectors)
	We construct a circle c with center in S and radius AS
	On the circle c we construct an arbitrary point C and connect in ΔABC
	At vertex C we construct a right angle
	Use this tool on the drawing to mark the top C ΔABC and drag on the work surface

With the last step in the construction algorithm when drawing the vertex C on the circle c, all students will notice that the value of the circumferential angle over the diameter of the circle c did not change at any time and was 90° and that was the goal to show.

VI. STUDENT MOTIVATION FOR WORK WITH GEOGEBROME

The first impression is sometimes the most important, so it is with the mathematical software GeoGebra. The opportunity should be taken when students meet GeoGebra for the first time and the lesson should be designed to take advantage of the interesting side of the program. Depending on which
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grade of primary school it is (fifth, sixth, seventh or eighth) and regardless of whether students will use the software on the school computer or will present the program and its capabilities teacher there are interesting assignments for the first lesson in which GeoGebra is used. Motivation is a term used to denote all those psychological factors that govern people's behavior. The most important aspects of motivation include intention to learn, interest in the material, striving for achievement, level of aspiration, success and failure in learning, knowledge of learning outcomes, intrinsic and extrinsic motives [9].

Students are differently motivated to learn mathematics which largely depends on both internal and external factors. For some students, sufficient motivation is just learning with which they satisfy the need to know external reality, which is accompanied to a large extent by the presence of intellectual emotions. In other students, internal motivation is insufficiently developed and in them learning is related to the external reward to which learning leads them (assessment, practical application of what has been learned, etc.). In addition to a favorable motivating factor for effective learning of mathematics in students, it is important to develop desirable habits and attitudes towards the subject of Mathematics.

Research has shown that students' attitudes and habits, related to mathematics, significantly influence their learning styles, understandings related to the nature of mathematical knowledge and the construction of cognitive style in students. Building desirable attitudes toward the subject of mathematics and mathematics as a science makes all of life's learning much more likely. Students develop a sense of creativity and make it easier for them to build compact, functional knowledge structures.[10]

One of the most important tasks of teachers is to develop students' interest in teaching materials. Since the interest develops more easily for the activity in which we have success, the teacher should occasionally allow weaker students to experience a sense of success.

Bruner (1966) believes that the "desire to learn" can be managed in teaching through discovery, provided that:

1. Motive of curiosity - teaching should be organized in such a way that it encourages and develops students' searching curiosity, which makes them satisfied and even more curious;

2. Motive of competence - teaching should be organized in such a way that each subsequent task requires a higher level of knowledge or habits than was achieved in the previous stage. This will satisfy the child's aspiration to reach the ability to interact effectively with his environment;

3. Motive of identification - the child has a strong desire to model his I in relation to some role models. The teacher is often that role model and this fact should be taken into account in the educational process;

4. Motive of interaction (cooperation) - the school should ensure that the student is not the object of learning but the subject of the teaching process[11].

Piaget (1980) also believes that the development of a child's cognitive abilities is favorably influenced by research procedures and methods of active learning. He believes that cognition and motivation are two aspects of the same process.

The most important reason for learning is natural human curiosity, the desire for knowledge, the need to deal with what interests us. Students will be happy to learn what is interesting to them and will not even ask where they will need this knowledge, if they have the material and way of learning interesting. It is important that the teacher presents the material as interestingly as possible. It is good that the lessons are dynamic, which can be achieved by applying various methods and teaching technologies. Independent activities are always more interesting to the student than dry transmission teaching. If students find the subject or way of teaching interesting, it will be easy to motivate them to learn[12].

GeoGebra in teaching mathematics allows students to gain direct experience of mathematical problems, motivate students and with their help students develop their own mental models, which allow more efficient hypotheses.

Experimentally, students can further consolidate their existing knowledge or directly correct unsustainable assumptions, depending on whether their hypotheses have withstood the test or not.

VII. ANALYSIS

Mathematical subjects today are difficult to realize through distance learning. It is difficult to write formulas, draw graphs or analyze necessary points. Geogebra is one of the ways to realize mathematics

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via the Internet. GeoGebra software is free and customizable to noon students. Incorporating into MOODLE is very easy. By getting acquainted with relatively new software, professors will better understand and explain it to students. I can place my ideas to other professors, which undoubtedly improves the quality of the material. This way, professors can more easily resolve their software concerns. GeoGebra is written in the Java programming language, which makes it easier to export files as dynamic Web pages. This feature allows you to easily and modestly create online math content (math applets). To create more complex content, knowledge of the basics of the Java programming language is necessary. The design of the GeoGebra user interface is also reflected in the intention to encourage efficient learning realized according to the principles of distance learning. The principle of multimedia prefers to use words and graphics instead of the words themselves - it is implemented in several ways in the GeoGebre user interface by combining text (in this case numerical and algebraic expressions) with graphic presentations. Technical support is another important factor when it comes to successful professional development with technology. On the one hand, the faculty must provide an appropriate technological and technical infrastructure consisting of hardware components, such as computers and projectors, software packages, which include certain general software tools and available online learning content, as well as a reliable Internet connection

VIII. CONCLUSION

Learning mathematics by discovery with the help of computers and dynamic geometry programs Geogebra, along with methodically designed and didactically designed interactive digital educational materials, ensures the activity of all students in the class, increases the motivation to learn mathematics, encourages independent drawing of conclusions, but also cooperation among students.

Through the above examples, this paper shows the great usefulness of the dynamic program GeoGebra in the teaching process. It is important that the student learns alone or in pairs on his computer, that he tries to discover new knowledge. The knowledge thus acquired will remain in the memory longer, and the student will learn to think. This will make each new problem much easier to solve and master the art of discovery.

However, whether this is feasible in teaching practice depends largely on school conditions. It has been shown that students are willing to cooperate in introducing changes in teaching, but if a mathematics teacher is unable to use the computer room for the purposes of their teaching, then they will not be able to implement the ideas described in this paper. Nevertheless, I hope that reading the paper will encourage other teachers to try to make changes in their pedagogical practice in accordance with the school conditions in which they work.

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