APPLICATION AND USE OF GEOGEBRA SOFTWARE IN TEACHING AND PRODUCING MATHEMATICAL CONTENT

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ABSTRACT

Today, the world of education has shifted its focus from teaching to learning, and such an approach is achieved due to the vast knowledge of rich technology. This applied and developmental research has been conducted with the approach of facilitating and increasing the understanding of learners, so in this study, we intend to explain the importance of software in face and virtual education and its impact on understanding mathematical concepts. In the following, we introduce one of the most widely used software in mathematics education, called GeoGebra, and also pictures of textbooks that help with this software in its Android version, run by mobile phone to learn more about its environment and how to work with this software. This article is applicable to elementary teachers, secondary school teachers, students, math students and those who are involved in the production of mathematical content in some way.

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1. Introduction

In recent years, teachers and students, even in remote parts of the globe, have not been deprived of new technologies and are using them more or less. With the boom in the market for new technologies and technologies, human life has changed dramatically, from advances in medical science to engineering or even education. Why are new technologies so important in human life and it seems impossible to put them away? The answer to this question can be explored in a variety of ways, but what matters is the impact of these technologies on human lives. Technologies in the field of communication can be described as a powerful tool for improving the quality and efficiency of education, so that it has been able to change traditional teaching methods so that there may be no need to be physically present in the classrooms (Dr. Ali Asghar Kia, A look at virtual education, 82). In today's world, what matters more than teaching is learning and mastery of the materials. As a result, training and Nurture has turned its attention to it.

In the past few years, we have always heard words such as traditional teaching and modern teaching, each of which represents different situations in education. In traditional teaching, the teacher shapes his activities according to the curriculum, the time of formation of cales is always fixed and in a specific framework, and the subject of the course is equally available to the students of Cales, while people in learning have different functions. Students simply listen to the teacher's explanations and are not actively active during teaching. After teaching the teacher, they also do homework and do not understand the ultimate goal and the outcome of the training. With such methods, learning is less likely to occur in students. Mathematics is one of the courses that is very extensive and requires objective understanding and understanding of problems with a different approach. Despite all the efforts in the field of education, the state of mathematics education is still not desirable and is always referred to by students as a rough and dry lesson. With the onset of the COVID-19 epidemic around the world, health protocols emphasized social distancing (2020, Sajed and Amgain). In many countries, in-person education in schools and universities was closed to reduce the spread of the coronavirus.

In order to ensure that the education of students and students is not interrupted during social distancing and the curriculum is continued according to the pre-defined schedule, various strategies were presented including virtual education. (2020, Al et Viner) One of the most important challenges facing teachers in the era of coronavirus is virtual and remote education including mathematics; According to the "Economics of Analin", Ali Bagherzadeh, head of the coordination center of the ministry of education and education, stated: "Due to the ongoing study, internationally and a case study that was conducted between third to seventh grade students and among more than five million students with an approach to the Prospective studies have been done 32 to 37 percent of the qualitative decline in science course and 50 to 63 percent of the learning decline in mathematics (1400). "According to these statistics, we see a sharp drop in students' education in mathematics; the more quality of teaching is virtually, the problems caused by it, such as student fatigue, learning disorientation, misunderstanding in the perception of textual concepts, lack of student activity, etc. It also decreases and consequently decreases the academic decline of virtual education. Therefore, in order to strengthen the virtual education infrastructure, one of the most important measures for teachers to benefit from the knowledge of new technology is to use software appropriate to the subject of the lesson as well as students' involvement in them. From the perspective of George Pollya (2001), the most important goal of mathematics education is to think and advise teachers to increase the level of thinking ability in their students. As a result, teachers' duties have become heavier and more complex than in the past, and traditional methods do not respond to the changes in the educational system.

Researchers have always sought to find an answer to fill learning gaps, eliminate problems and deficiencies caused by learning and teaching process defects. They have been looking for ways to lead students to an interactive and enjoyable learning experience so that they understand the basic foundations and requirements and profound concepts of mathematics (Thornton, 142-1997). According to this interpretation, in fact, the most effective methods for managing the calves are those that attract students' interest, create a lot of motivation to learn, and provide challenging assignments within the limits of students' ability (2001, Oslavin). What in Modern Education It is important to educate students who are the producers and creators of knowledge, not the mere recipient and consumer of it. It should be said that the purpose of creating schools is to provide an

exciting, educational, and hopeful place that can overcome the attractions of school closures and replace it with educational cyberspace. But using the experiences of the time of Corona can be used to combine schools with virtual education to enrich education. To achieve this goal، creating the right infrastructure، empowering manpower، producing the right electronic content can be very effective and efficient in creating a new hybrid space. (Daneshgar, 2020) The use of educational technology at the school level can be one of the most effective methods to motivate and enhance learning. Some of these technologies are made up of software.

Software that can run on your computer and mobile phone. Educational software, whether in person or in virtual education, can improve learning outcomes and create more interaction between students and educators by being placed next to the traditional method. Also, due to providing numerous and different examples, learning and solving problems, it advances the speed of teaching, repetition of content and their efficiency to suit each individual.

Using software to teach mathematics can have the following benefits:

- Facilitating the teaching of mathematical concepts especially for teachers and creating a happy and interesting atmosphere for students
- Deeper learning in an interactive, experimental and exploratory environment with teacher and other students
- Motivation for students to learn math and not be afraid of it
- Enhance visualization
- Save time and make useful use of
- Encourage students to do homework with software because of their attractiveness
- Exploring and completing mathematical research ideas

In the following context, we try to introduce the important educational software "GeoGebra" that plays a useful and effective role in the field of mathematics and teaching in the field of in-person and analytical, and provide a variety of examples.

2. Software Introduction

First of all, we need to know what GeoGebra software is and what features it has. GeoGebra is a dynamic mathematical software that connects three branches of geometry, algebra and arithmetic so that it can be used to teach and learn mathematics in school. This free software has been designed and implemented by Marcus at the University of Salzburg Hohn Warter in Austria and his accompanying team, and has an easy user interface with powerful features that can be used to teach mathematics in an interactive way and like what is on web pages. With it, you can see all the complex mathematical problems objectively and gain experience and scientific experiments in the field of mathematics and geometry. Simple environment and clear instructions are among the advantages of this software. GeoGebra software environment can be Persian, so it can be used for all levels of education and teachers; in other words, GeoGebra is the most suitable option for teachers and students in teaching and learning mathematics in comparison with other similar softwares, in terms of capabilities, drawing facilities, interfaces, extent of practice and educational content, because anyone can be trained in a short period of time. The environment of this software is familiar and its various features are known.

The Java output applet is a flawless software that enables the user to generate interactive lesson plans of high quality. The software is written in Java and HTML. There are different versions for different operating system and with different languages. The important thing about this software is that it can animate and draw mathematical forms (challenges of teaching GeoGebra to the first high school students of Chadegan city – Rooh Ahl Mirzaei, 3). The software is available on multiple platforms such as iPad (Android), tablets, Mac and Linux for desktop and the web.

3. GeoGebra Software Educational Objectives

The use of technology in mathematics education has always been effective. Hence the software has been built to better enable students to learn mathematical concepts.

GeoGebra is suitable for teachers who are active and problem-oriented because it can solve math problems both in class and at home so that students are highly involved in the subjects. The use of educational software helps students learn more abstract subjects such as mathematics. In fact, it may be difficult and even boring to understand some mathematical theorems and how to prove them for students, especially those with lower intermediate levels, but when they are designed and implemented in a geogebra environment that has a variety of capabilities, including animation, and are presented to students, they will be much more attractive; even the spirit of students' interaction and cooperation with their teacher and friends is high. Gone, learning happens effectively and also increases the retention of the learned material in the students' minds. Since the ability to change the color and shape of points, charts, lines and ... Obviously، the content generated will be doubled. In this software, the user can use all geometric objects such as lines, circles, elliptical shapes and ... And fear him. Two attractive features of this software are one possible to output the work in the form of a web page and the other in the form of a photo file. This way the user can easily display the result anywhere. In online education, the output capability of the web can also be used well. A very important tool for animation 8 is "slider"; it is actually a tool that we use to change the value of a variable, and it has a lot of use, especially for creating a dynamic environment in teaching, and can be creatively produced educational content.

Research shows that the use of simulation software has a great impact on understanding and deepening the content of mathematical education. If the teacher produces a simulated sample and displays it to the students, the educational benefit will be high, and if this content is available to the students, it will have better results. When the student is taught the lesson, he will be the most knowledgeable.

Among the goals pursued by GeoGebra in education are the following:

- The possibility of multiple representations of concepts related to line equations and trigonometry in order to understand them more deeply ,
- Creating meta-cognition and the possibility to use in the coming years for representations and deepening mathematical concepts, especially in discussions related to functions and drawing diagrams ,

- The opportunity to emerge and update the innovation and creativity of knowledge Learners in effective innovations ,
- Creating a healthy and effective competitive environment ,
- Producing usable content of students and teachers,
- Diversity in teaching and utilization of types of intelligence among students,
- Promoting and developing diversity in the teaching-learning process ,
- Providing opportunities for students to present and explain their own products (Journal of Online, Mathematical Analytical Learning with GeoGebra software, Alireza Hamdollahi).

Through this powerful software, the following activities can be performed:

- Algebraic Operations,
- Graphical operations such as geometric drawings Types of charts, animating charts and shapes ,
- Account Differential and integrals such as calculation of limit types of univariate functions, derivative and integral calculation ,
- Performing various types of matrix operations ,
- Calculations in complex number field ,
- Performing statistical calculations and drawing statistical graphs.

In the next section, you will see the various educational examples that we have worked with this software in the Android version as a photo with a brief description. It is important to note that these examples are only part of the practical examples. GeoGebra software has many features that you can learn by working in its environment. You can also find and work with more examples from the "Search GeoGebra Learning Resources" section on Android and even the web, which have been designed by other users.

The Windows version of this software has many capabilities for the audience, but the reason for using the Android version is that the number of people who have access to a mobile phone is much greater than those who have computers and laptops, as well as anywhere and can easily use it. Teachers can also easily use it to produce educational content – especially virtual tutorials – and provide videos or images to their students.

4 .Various GeoGebra Entries and Implemented Examples

The Android version of GeoGebra has various inputs for things such as drawing 3D shapes and graphs and is selected according to the needs of the audience. Each of these calculators can be installed separately on your Android phone, as they are available separately and in one place. In each input there is a section called "algebra" where all information entered in the environment is written in it, such as coordinates of points, rules of functions, lines, length of line segments, slippery tools, etc. There is also a section titled "Tools" and there are various windows that need to be touched to use each tool to show up at the bottom of the screen for further guidance. It is recommended that the audience try the window or various software tools and be well acquainted with its capabilities, because the user can learn to work with the program environment easily without the help of others in the shortest time. Following are examples of geometry, 3D calculator and graph. In each of these sections, there are various windows, including basic tools, editing, drawing, measurement, dots, lines, circles, polygons, conversions, aspects, plates, curves, and other items that are categorized in the Tools section, which make it easier to access the required tools. For example, in the 3D calculator section, to specify the common area of the two levels, you should select the "intersection of two levels" from the curves or base tools.

5 . Geometry Department

Among the things that we have worked with this program in this section are geometric transformation including rotation, symmetry and conformation, location of semistructures, squared verticals, medians and heights in triangles and discussions related to circle.

Example 1. Rotation and Symmetry

The student can draw a shape or polygon and rotate it around a point with different angles and in the desired direction; or find it relative to a line or point of symmetry. These examples will be useful and interesting for students in the fifth, sixth and seventh grades.

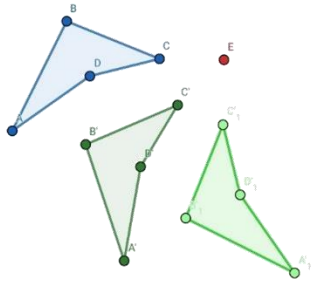

Image-1 ABCD polygon rotation around point E
at 45 and 90 degrees clockwise

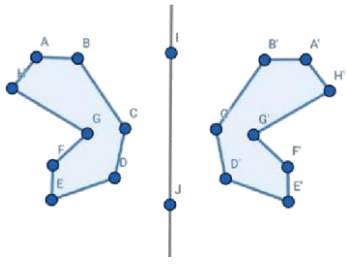

Image -2 Symmetry of the shape relative to a line
(axial symmetry)

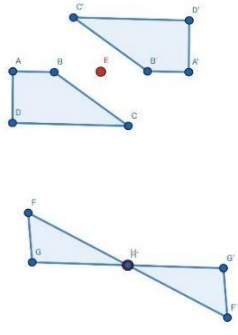

Image -3 Symmetry of the shape around a point
(central symmetry)

Example 2. Heterogeneity

The concept of homogeneity mentioned in the book of Geometry 2 is one of the examples we have mentioned. The user can draw a polygon or line and create it with arbitrary coefficient relative to a point of congruity. In all transformations, the student can observe that by magnifying or minimizing the original shape, the transformed form changes along with it.

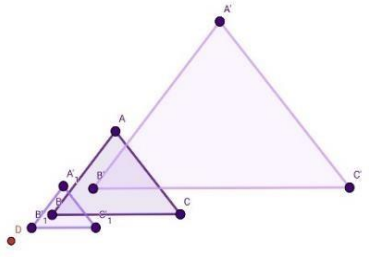

Image -5 Homogeneity of triangle ABC to point D with coefficients of 2 and 0.5

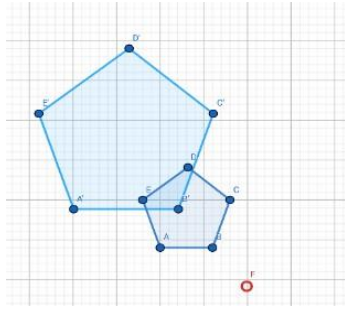

Image -4 Convergence of the Figure Relative to Point F with a

Example 3. Location of semistructures, verticals, middles, and heights in triangles

In the images below, we show the location of fair, semi-structured, height and middle in a variety of triangles with sharp angles, outgoing and upright angles. As shown from the pictures, the location of the semi-structured symmetrical and the middle is always inside the triangle; the location of the vertical half if the triangle is right-angled, on the chord, if it has an angled angle, outside the triangle, and if angles are high, it falls inside it; and the location of the elevations if the triangle is right-angled, on the right vertice, if it has an angled angle, outside the triangle and if angles are high, it falls inside it.

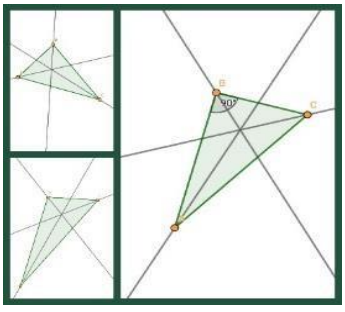

Image -6 Location of semi-structures in triangle

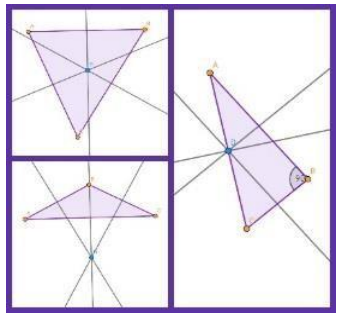

Image-7 Location of the vertical symmetry in the triangle

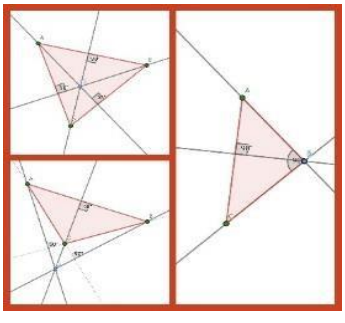

Image -8 Location of the height in the triangle

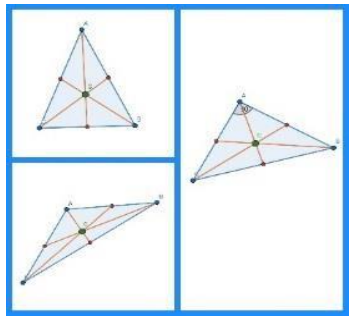

Image -9 The location of the middle Hammers in the triangle

Example 4. Circle

In the following, look at the examples that have been worked with the circle; image 10 is related to the angle created on the perimeter of the circle, drawn from two ends of its diameter, which is always equal to 90 degrees; of course, the proof is comfortable and related to the inscribed and central angles that are mentioned in the eighth grade book. Figure 11 also points out that "from each point outside the circle, two tangential tangents are drawn to the circle, which are always the same length." This theorem is also proved in the textbook through the coherence of triangles. Such examples show that the teacher can easily work with this software in teaching subjects and can better understand the

meaning and meaning of the theorems to the students; therefore, this software helps teachers in teaching and in a way makes their job easier!

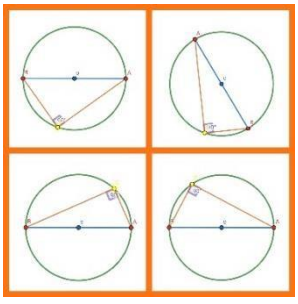

Image 10

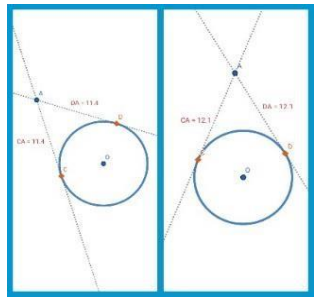

Image 11

6 . 3D calculator section

The results of Thames show that one of the main reasons for the low learning of Iranian students in geometry is the weakness of visual and spatial skills of Iranian students (Aminolroaya, 2009). One of the main problems of students in school is understanding geometry problems and visualizing three-dimensional shapes. Students generally face less problems in solving algebra problems, but when it comes to geometry, drawing and visualizing shapes, most of the knowledge Learners are not able to understand such problems because they do not attach much importance to the enhancement of spatial visualization in schools. In the 3D calculator section of this software, there are many tools that increase the ability of the learner's visualization, because the student can see 3D objects with the help of hand rotation from different angles and can better imagine objects in space. The various tools that are very useful in this application, but drawing three-dimensional shapes such as sphere, cone, prism and ... One can refer to the tool creating the intersection of the two levels (to observe the common area of the two levels) and to display the wide shape of the volumes.

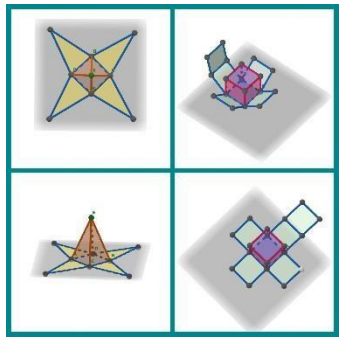

Image -12 Wide Shape Cube and Pyramid with Base Square

Example 1. Cone Sections

One of the most important examples of this section is about the conical sections mentioned in the second chapter of Geometry 3 that show the common chapter of a plate and a conic surface. According to the different conditions, if the plane is drawn in such a way that it is perpendicular to the cone surface axis and does not pass its vertice, the common area of a circle will be (Img. 13). If the plane is not perpendicular to the axis, nor parallel to the conical cross section generator and cuts only one of the two halves of the cones, the resulting surface will be an ellipse (Img. 14). If the plane is parallel to the generator and the vertices are parallel to the generator and the vertices of the plane are parallel to the generator. The cone does not cross, in which case the plane and the cone surface are a parabola (Img. 15) and also if the plate is such that it cuts both the upper and lower parts of the cone surface and does not contain its axis, then the interface of the plate and the cone surface is a hyperbola (Img. 16).

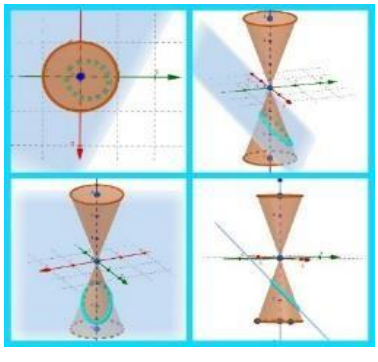

Image -14 Conical Cross Section

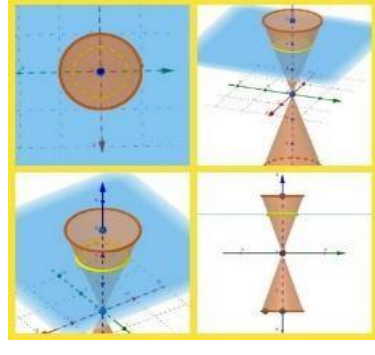

Image -13 Circular Cone Cross Section

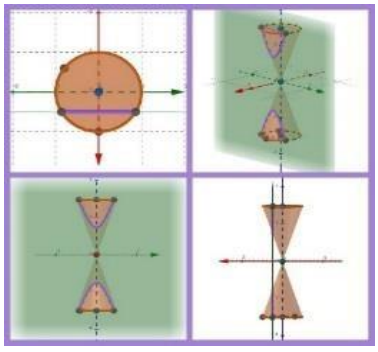

Image -16 Hyperbolic Conical Cross Section

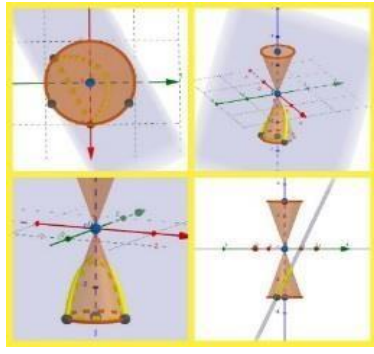

Image -15 Parabolic Cone Cross Section

Example 6. Rotation of the shape around its side or an axis.

From other things that we can refer to in the 3D calculator section of the software, rotation of a shape such as semicircle, quadrant, rectangle, triangle and ... It revolves around its axis or side that three-dimensional aspects, such as spheres, hemispheres, cylinders, cones, etc. is created. The most important tool we have used in these examples is the "Revolution of Surface" tool. You can see the results in the following screenshots.

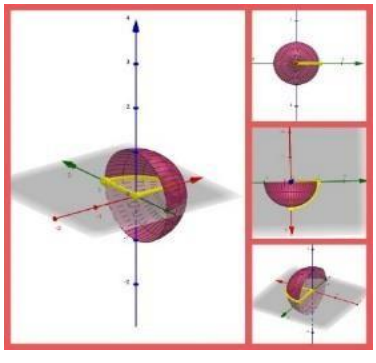

Image -18 Quadrant rotation around its radius

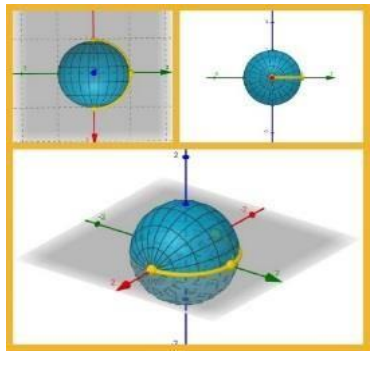

Image -17 of the semicircular rotation around its diameter

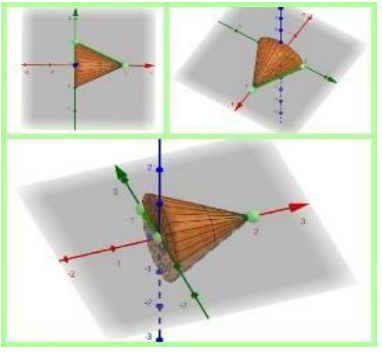

Image -20 Rotation of the triangle around its right side

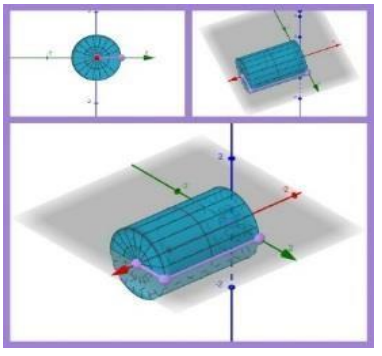

Image -19 Rectangular rotation around its length

One of the interesting features in the 3D calculator section is the existence of an augmented reality feature or its acronym "AR" which you will see in the lower right corner. This feature, which adds the entire 3D screen simulated to our real world via mobile camera, creates a live physical view that can be moved by the user and simulated with geometric shapes and 3D real-world volumes.

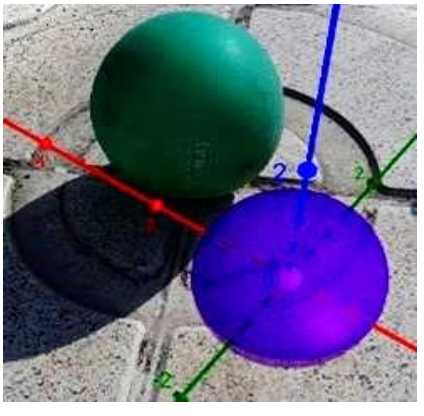

Image -21 Augmented Reality Features in GeoGebra

7. Charts section

Other parts that are very useful in this software is the graphing part of this software. In general, students who are good at charts are better able to master other areas of mathematics.

Example 1. Drew $\boldsymbol{ax^2 + bx + c}$ and view its changes by changing coefficients $\boldsymbol{a, b, c}$.

In the algebraic and input section, we write the standard parabolic equation $\boldsymbol{ax^2 + bx + c}$ to draw its shape. Now by changing the sliders (or values $\boldsymbol{a, b, c}$), the shape of the graph will also change and the different modes will be shown to the student objectively.

This operation shows a good point; with the change in the coefficients, what changes will be made in the shares? We can see by our observations that if we change the $\boldsymbol{x^2}$ or $\boldsymbol{a}$ coefficient, the graph becomes more open or closed.; so that if the value $\boldsymbol{a}$ is greater than zero, the parabolic crater will be upward, and if it is negative, the crater will be downward.

Now if we change the value of $\boldsymbol{c}$, the chart will move up or down. If the $\boldsymbol{c}$ value increases, it will move the same way to the top, and if it decreases, it will move downward.

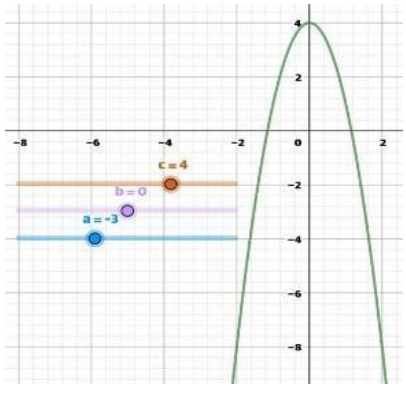

Image -22 Parabola changes by changing the values $\boldsymbol{a}$ and $\boldsymbol{c}$

Now the question arises as follows: Given that $\boldsymbol{a}$ and $\boldsymbol{c}$ are constant, what changes will be made by changing $\boldsymbol{b}$?

Changes to $\boldsymbol{b}$ cannot be predicted on paper normally, so we use the GeoGebra software to show the geometric location of changes to $\boldsymbol{b}$.

To make it simpler, we're working on the parabola head. Assuming $a = 1$ and $c = 0$, and by changing $\boldsymbol{b}$ the parabolic vertices take a path. To guess the path traveled by parabola or better the geometric location of the parabolic vertex, we find the extremity point of the function. To find the extreme points $(absolute\ and\ relative\ max, min\ points)$, we either have to enter the extremity command which is $-\boldsymbol{b}/_{\boldsymbol{2a}}$,or directly use the predefined GeoGebra software itself. So the vertices are marked as points on the parabola chart; we touch the point and activate the tracking section from its settings. By changing the value of $\boldsymbol{b}$, the change of position effect The vertices are created as a set of points on the screen. To be more confident, we can change the value of $\boldsymbol{a}$ and $\boldsymbol{c}$ and apply tracking again. We conclude that the shape that the vertex creates by changing the value of $\boldsymbol{b}$ is the symmetry of the function we are looking for. So The student can prove that the geometric location of the parabola vertex equals $-\boldsymbol{ax^2} + \boldsymbol{c}$ by changing the value $\boldsymbol{b}$ when $\boldsymbol{a}$ and $\boldsymbol{c}$ remain constant.

Example 2. Graph of the $\boldsymbol{f(x) = x^n}$ function for even and odd numbers.

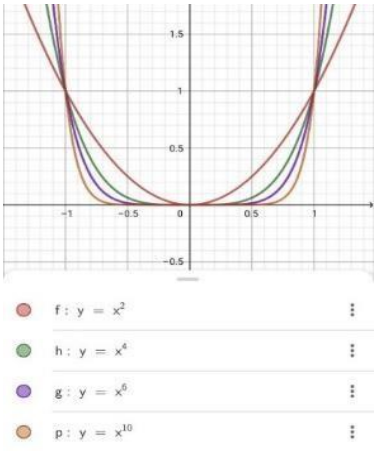

Image -24 $\boldsymbol{f(x) = x^n}$ function chart per $\boldsymbol{n}$ even

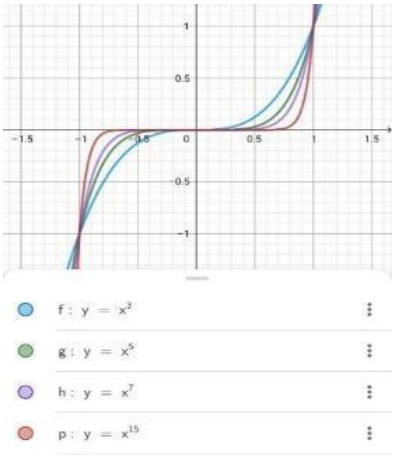

Image -23 $\boldsymbol{f(x) = x^n}$ function chart per $\boldsymbol{n}$ odd

According to Images 23 and 24, the function $\boldsymbol{f(x) = x^n}$ is defined for all real $\boldsymbol{x}$ values. Note that when $\boldsymbol{n}$ gets bigger, at distance $\boldsymbol{(-1.1)}$ the curves tend to expand on the $\boldsymbol{x}$ axis and for $\boldsymbol{|x| < 1}$ They go up steeper; all curves in this shape pass both from point $\boldsymbol{(1.1)}$ and from the source.

8. Conclusion

Before the advent of virtual education, many teachers considered traditional teaching methods sufficient to teach concepts. With the outbreak of the COVID-19 epidemic around the world, there was a huge upheaval in education. With the expansion of distance education, the need for teachers' empowerment in applying new educational tools became more evident. GeoGebra software is one of these educational tools that can enrich the teacher's work and transform the boredom of the virtual classroom into a joyful and effective learning environment. Considering the extent of technology and its significant impact on different levels of life, its useful and effective role in the field of education cannot be overlooked. So far, many scholars and thinkers have pointed to the unmatched role of technologies and technologies, and he has written many books and articles on this subject. From this article, it can be concluded that the use of software is useful for both students in the field of learning and teachers in the field of face to face and virtual education. In this article, GeoGebra software and its features were mentioned, and as many examples as possible, various examples have been worked out to some extent. What is important is the useful and effective use of facilities for teaching and appropriate feedback of teaching-learning process. All technologies have been created to make life easier for humanity; it is hoped that humans will take steps to make use of it.

Disclosure statement

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