THE IMPACT OF GEOGEBRA IN TEACHING MATHEMATICS AND IN MATH TEACHERS PROFESSIONAL DEVELOPMENT

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Abstract :

Technology is essential in teaching and learning mathematics, it influences the mathematics that is taught and enhances student's learning. This paper presents new trends in technology and learning through GeoGebra, which could be especially important for the future development of e-learning for College mathematics. GeoGebra is a free, open source, multi-platform, translatable, dynamic mathematics software that has an extensive and very active international community of users who support each other with teaching materials and technical support in the use of the program. Examples of the use of GeoGebra will be shown using some concepts of 3D-geometry.

Keywords: *dynamic mathematics software, geometric concepts, college mathematics.*

Introduction

GeoGebra is a Dynamic Mathematics Software (DMS) for teaching and learning mathematics from middle school through college level. It is as easy to use as Dynamic Geometry Software (DGS) and also provides basic features of Computer Algebra Systems (CAS) to bridge some gaps between geometry, algebra and calculus. GeoGebra is open source software under the GNU General Public License and freely available at www.geogebra.org. There, you can either download installers for multiple platforms or launch the software directly from the Internet using GeoGebra Web Start.

GeoGebra was created to help students to gain a better understanding of mathematics. You can use it for active and problem-oriented teaching, it fosters mathematical experiments and discoveries both in classroom and at home. Mathematical skills and knowledge are steadily gaining importance for everyday life in a lot of countries all around the world where “mathematics is viewed as a necessary competency for critical citizenship” .This heightens the importance of making mathematics education accessible to all students and increasing their mathematics proficiency so as to prepare them for life outside school. In order to provide a higher quality education for students, capable teachers who are willing to implement creative learning environments with technology for the purpose of maximizing their students’ learning success are desperately needed.

Short History of GeoGebra

The development of GeoGebra began in 2001 as Markus Hohenwarter’s Master’s thesis project at the University of Salzburg, Austria. After studying mathematics education as well as computer engineering, he started to implement his idea of programming a software that joins dynamic geometry and computer algebra, two math disciplines that other soft-ware packages tend to treat separately. His main goal was to create an educational softwarethat combines the ease of use of a dynamic geometry software with the power and features of a computer algebra system, which could be used by teachers and students from secondary school up to college level. After publishing a prototype of the software on the Internet in 2002, teachers in Austria and Germany started to use GeoGebra for teaching mathematics, which was, at this point, rather unexpected by the creator, who got a lot of enthusiastic emails and positive feedback from those. In 2002, Hohenwarter received the European Academic Software Award EASA , which finally inspired him to go on with the development of GeoGebra in order to enhance its usability and extend its functionality. Further

development of GeoGebra was funded by a DOC scholarship awarded to Hohenwarter by the Austrian Academy of Sciences, which also allowed him to earn his PhD in a project that examined pedagogical applications of GeoGebra in Austrian secondary schools.

Design of GeoGebra

Currently, there are two types of educational software that connect the mathematical fields of geometry and algebra and are used for mathematics teaching and learning. On the one hand, there is dynamic geometry software (DGS) that allows users to create and dynamically modify Euclidian constructions. Geometric properties and relations between objects used within a construction are maintained because manipulating an object also modifies dependant objects accordingly. Some dynamic geometry programs even provide basic algebraic features by displaying the equations of lines or conic sections, as well as other mathematical expressions which usually can't be modified directly by the user. On the other hand, there are computer algebra systems (CAS) which symbolically perform algebra, analytic geometry, and calculus. Using equations of geometric objects, a computer algebra system can decide about their relative position to each other, and display their graphical representations. Many computer algebra systems are also able to plot explicit and sometimes even implicit equations. Generally, the geometric representation of objects can't be directly modified by the user.

GeoGebra is an attempt to join these two types of software, whereby geometry, algebra, and calculus are treated as equal partners. The software offers two representations of every object: the numeric algebraic component shows either coordinates, an explicit or implicit equation, or an equation in parametric form, while the geometric component displays the corresponding solution set. In GeoGebra both representations can be influenced directly by the user. On the one hand, the geometric representation can be modified by dragging it with the mouse, whereby the algebraic representation is changed dynamically. On the other hand, the algebraic representation can be changed using the keyboard causing GeoGebra to automatically adjust the related geometric representation.

One of the key tasks in education is to motivate students and make them feel interested. Naturally, capable teachers had been able to motivate children even before computers became widespread without feeling the need for various types of software. Then the reader has every reason to ask why we should begin using software now? Well, first of all students have changed a lot since the world they live in has also undergone great changes. Secondly, the more varied tools teachers have, the more efficient they become. Last but not least, mathematics software very often provides teachers with such new tools that are not replaceable with anything else. Besides motivation, another major task is differentiation, since in almost every case teachers have to deal with heterogeneous groups. Using software, teachers are able to create extra materials of various content and level thus becoming able to properly differentiate between students. A substantial part of teachers' work is the preparation of different types of extra material such as test banks, progress tests, summaries etc. The use of various software utilities facilitate and accelerate this task. With the help of GeoGebra teachers are able to easily create precise and spectacular figures. Moreover, they can publish their dynamic worksheets on the Internet at ease, making them accessible for their students. The goal is to use GeoGebra to provide an environment for active exploration of mathematical structures through multiple representations, or to show students some aspects of the mathematics that are not possible with pen and paper.

Geometry has been defined by various scholars; "Geometry is a complex interconnected network of concepts, ways of reasoning, and representation systems that is used to conceptualize and analyze physical and imagined spatial environments" .

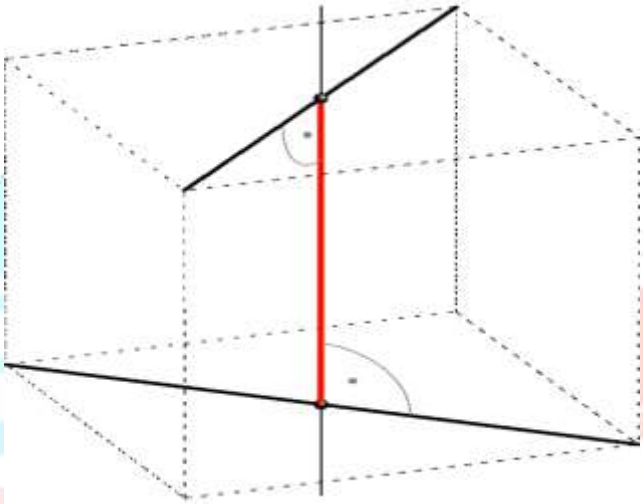
Geometry is also defined as a branch of Mathematics that is concerned with shapes, sizes, relative position of figures and the properties of space. Geometry is the branch of mathematics concerned with lengths, areas and volumes .

Geometrical definitions have to do with space and shape. Hence when defining a geometrical shape, properties such as angles and measurements are used. According to (Clements and Battista, 1990) "underlying most geometric thought is spatial reasoning which is the ability to see, inspect and reflect on spatial objects, images, relationships and transformations".

In the process of teaching topics and concepts involving Geometry, the teacher expects his/her students to be able to visualize figures, shapes and planes that many not be very obvious to the student. This concept is what makes geometry unique and difficult to learn and teach. This is because spatial ability is not easy for all students. In teaching the concepts of geometry, the teacher is faced with the task of helping learners 'see' the objects represented in the image and further derive some meaning from it. In the following examples we see how GEOGEBRA is useful in visualising some geometric concepts .

Example 1: Shortest distance between two skew lines

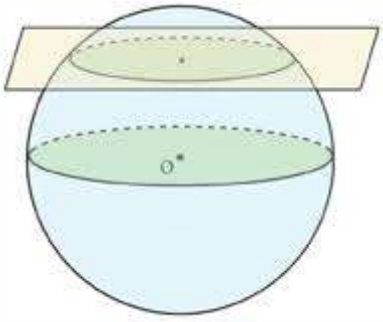
Any two non-parallel and non-intersecting lines are called skew lines. Skew lines are non coplanar. Shortest distance between two skew lines is difficult to visualize. Shortest distance between two skew lines equals the distance between their intersections with their common normal line. For every pair of skew lines exists a unique line that intersects both



Skew lines

lines and is perpendicular to both lines. This line is called normal line of two skew lines.

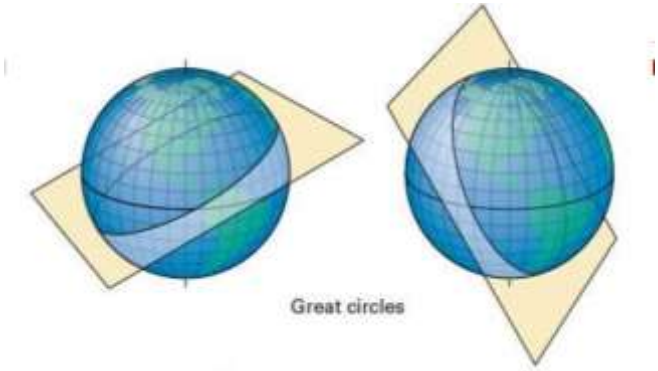
Example 2**: Plane section of a sphere**



If **S** is a sphere and ∏ is a plane, the non empty set of points common to sphere **S and** the plane ∏ is called a plane section of sphere. Then we say that the plane intersects the sphere. A plane section of a sphere is a circle.

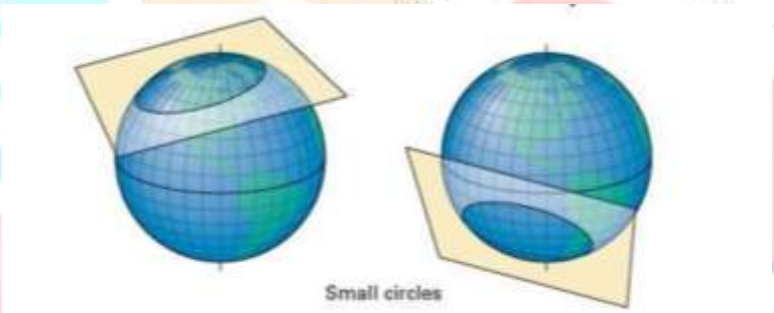
Example 3:Great circle

If a plane passes through the centre of a sphere, then the plane section of the sphere is called a great circle, irrespective of the inclination of the plane . The centre and radius of the great circle are respectively the centre and radius of the sphere.

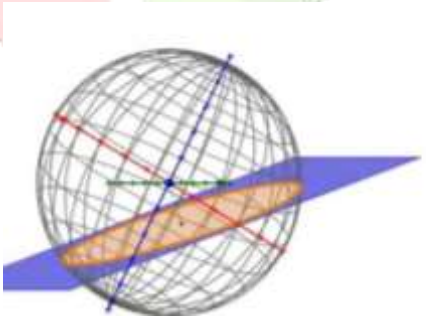


Example 4:Small circle

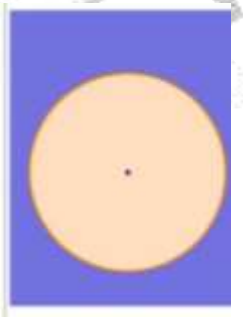
If the plane does not passes through the centre of the sphere and intersects the sphere ,then the plane section of the sphere is called a small circle.



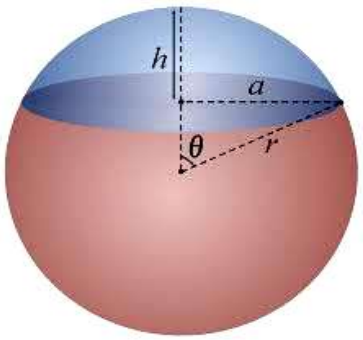
The centre of the small circle is the foot of the perpendicular from the centre of the sphere to the plane and the radius of the small circle is less than the radius of the sphere.



Intersection of plane and sphere



Small circle with centre



In the above diagram 'a' is the radius of the small circle and 'r' is the radius of the sphere.

Using GeoGebra we can make the students visualise and there by understand the geometric concepts like, planes bisecting the angle between the two intersecting planes, intersection of three planes, sphere through four given points, sphere through given circle, right circular cone, enveloping cone e. t. c.

CONCLUSION:

GeoGebra has been rapidly gaining popularity among teachers and researchers around the world, because it is easy-to-use dynamic mathematics software that combines many aspects of different mathematical packages. In addition, because of its open-source nature an extensive user community has developed around it. Mathematics teachers are encouraged to use technology in the teaching and learning of mathematics, as it allows teachers to convey their teaching ideas according to the topics. It may require some time before teachers become familiar with the use of GeoGebra in the classroom. In addition, it also requires teachers to spend some time in order to produce images or graphics in front of students, whereas the traditional approach to teaching only involves lecturing or drawing on a white board. Thus, the explanation on topic-related concepts takes a longer time compared to explanation on procedures. This is because concepts involve more activities that use GeoGebra and teaching aid materials, such as pictures that are uploaded in GeoGebra. Procedures produced can be created by students themselves using GeoGebra. For example, GeoGebra software can produce graphics directly, without requiring materials outside the GeoGebra program. The advantages of GeoGebra software have made teachers more creative in planning more effective lessons and lesson delivery, which involves two-way learning. The use of GeoGebra in the teaching and learning of function affects students' conceptual and procedural knowledge. Hence, GeoGebra can be considered as an alternative for schools and colleges to run their mathematics laboratories and to use GeoGebra in the teaching and learning process. The use of GeoGebra gives teachers an opportunity to create different teaching techniques.

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