

## APPLICATION OF GEOGEBRA SOFTWARE IN GRAPH SKETCHING

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### ABSTRACT

Many studies have shown that information and communication technology (ICT) may help to assist and transform teaching and learning. In mathematics, ICT can assist students and teachers in performing calculations, analyzing data, sketching a graph, and exploring mathematical topics. As a result, it can increase the understanding in mathematics. The purpose of this paper was to show the example of using a free-software called GeoGebra in sketching a graph of two dimensional (2D) and three dimensional (3D) function. Besides sketching the graph, GeoGebra can also be used on finding intersection point, gradient of function, first and second derivatives and others. GeoGebra is an interactive geometry, algebra, statistics, and calculus program designed for learning and teaching mathematics and science at all levels, from elementary to university level.

**Keywords:** *GeoGebra, ICT, mathematics, Two Dimensional (2D), Three Dimensional (3D)*

### Introduction

In this globalization era, many of our students' learning needs and interests are addressed by using technology especially in learning process in mathematics. As a response for these needs, many of software application were produced to build geometric models and solve analytical and algebraic problems. As a result, GeoGebra is one of the greatest applications for building and illustrating mathematical problems.

GeoGebra was created by Markus Hohenwarter in 2001/2002 as part of his master's thesis in mathematics education and computer science at the University of Salzburg in Austria. Supported by a DOC scholarship from the Austrian Academy of Sciences he was able to continue the development of the software as part of his PhD project in mathematics education. During that time, GeoGebra won several international awards, including the European and German educational software awards, and was translated by math instructors and teachers all over the world to more than 25 languages. Since 2006 GeoGebra is supported by the Austrian Ministry of Education to maintain the free availability of the software for mathematics education at schools and universities. In July 2006, GeoGebra found its way to the US, where its development continues at Florida Atlantic University in the NSF project Standard Mapped Graduate Education and Mentoring (Hohenwarter & Preiner, 2007).

There are many applications in mathematics used GeoGebra software. Based on previous research, GeoGebra was a tool for enhancing student progress and instructor effectiveness (Wassie & Zergaw, 2018). In Calculus course, GeoGebra can be used in a

differential to learn derivative topics through dynamic graphics (Sari et al., 2018). The findings illustrate that when a secant line evolves into a tangent line, GeoGebra's dynamic feature allows students to zoom in on a graph, which corresponds to taking infinitesimal.

Besides that, the impact of combining GeoGebra with the teaching of linear functions on Grade 9 students' achievement was explored (Mushipe & Ogbonnaya, 2019). It was found that GeoGebra was more effective in improving student achievement, especially in linear function. In addition, GeoGebra was also used to explain and analyse the impact of learning integral calculus students. This software was useful to help students understanding the material of integral calculus such as area between two curves, surface area, and volume of rotary object (Machromah et al., 2019).

### **Geogebra : A Brief Overview**

GeoGebra is an interactive mathematics software that can be used to teach algebra, geometry, calculus, statistics, and other related subjects. This software package is available online without no cost and may be used both at school and at home, giving students tremendous opportunity to complete their assignments. This Graphing Calculator is also available in the Google Play Store for android user and the App Store for iOS devices. It can be download at [www.geogebra.com](http://www.geogebra.com). The most significant benefit of utilizing GeoGebra is that it is user-friendly, allowing students to navigate and evaluate their own work. Figure 1 below shows the interface of GeoGebra website that can be access online.

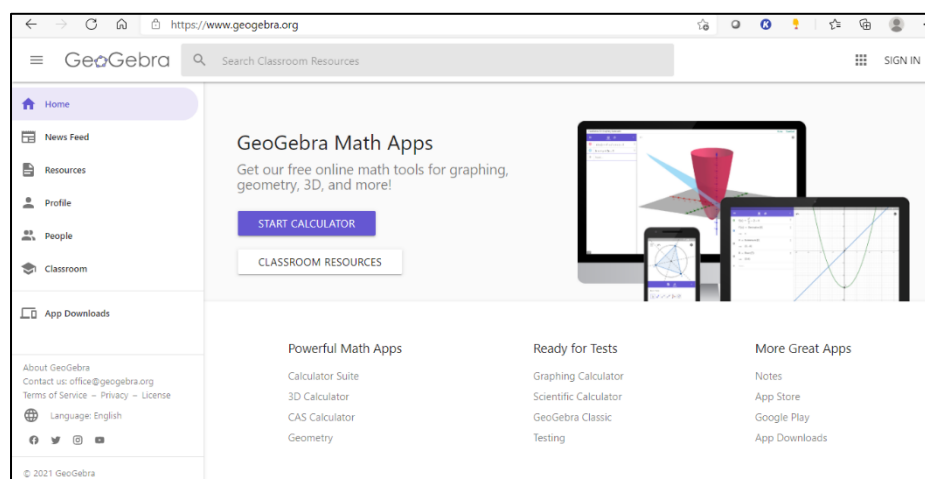


Figure 1: GeoGebra website

GeoGebra is an open-source mathematics teaching and learning software that combines geometry, algebra, and calculus in a fully linked and user-friendly environment. An algebra view and a geometry view or a graphic view comprise GeoGebra's interface as shown in Figure 2 below.

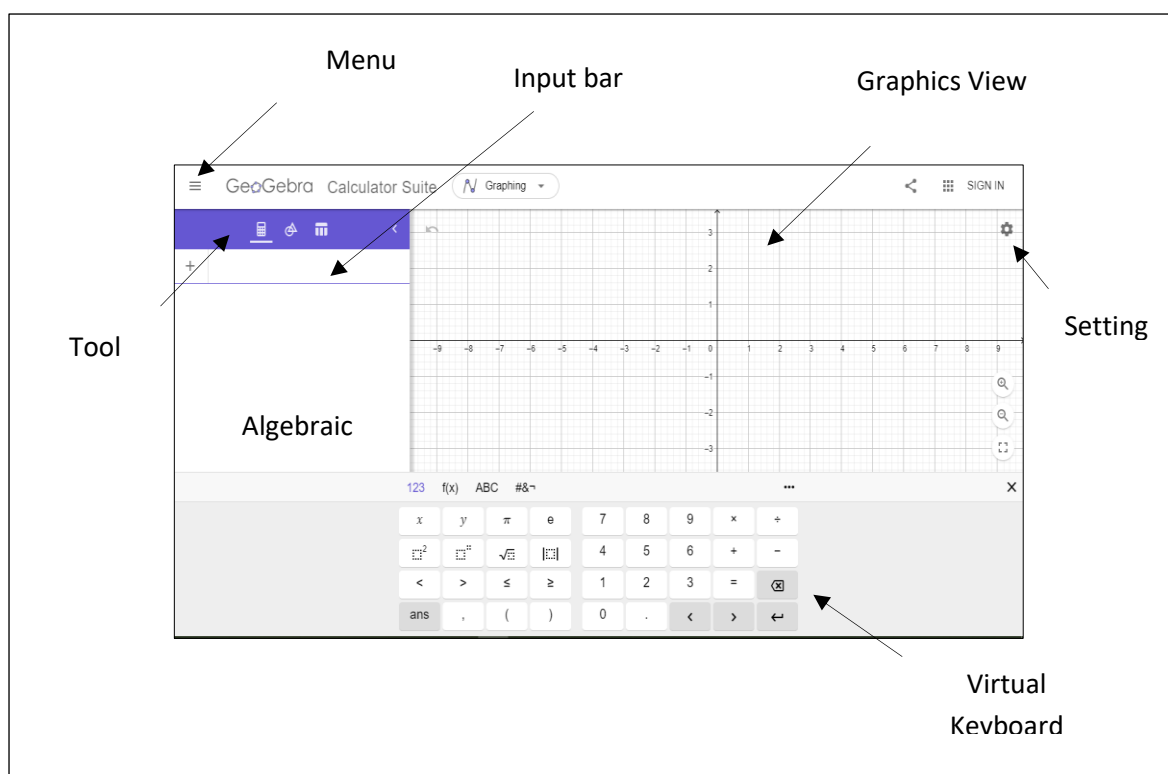









Figure 2 : GeoGebra interface

Table 1 below shows some of the icon displayed on GeoGebra interface.

Table 1 : Description for the icon display on GeoGebra interface

No.	Icon	Description
1	 Algebra	Opened next to graphics view
2	 Tools	Displays the graphical representation of objects created in GeoGebra
3	 Table	For creating a table of value
4		Main menu of GeoGebra
5		Share button
6		Displays the setting for graphic view
7		Used to type and insert important function.

## Graph Sketching

This section will be discussed on the technique that can be used for sketching a graph of 2D functions and 3D function using GeoGebra software.

### Example 1: 2D Function

Given that  $f(x) = x + 5$  and  $g(x) = -\frac{1}{2}x^2 + 7$ .

- Sketch the graph of both functions.
- Find the intersection(s) point (if any).
- Find the derivatives of  $f(x)$  and  $g(x)$ .

By using GeoGebra software, students can easily sketch graph by typing on the Input Bar using virtual keyboard. Figure 3 below shows the graph of  $f(x)$  and  $g(x)$ .

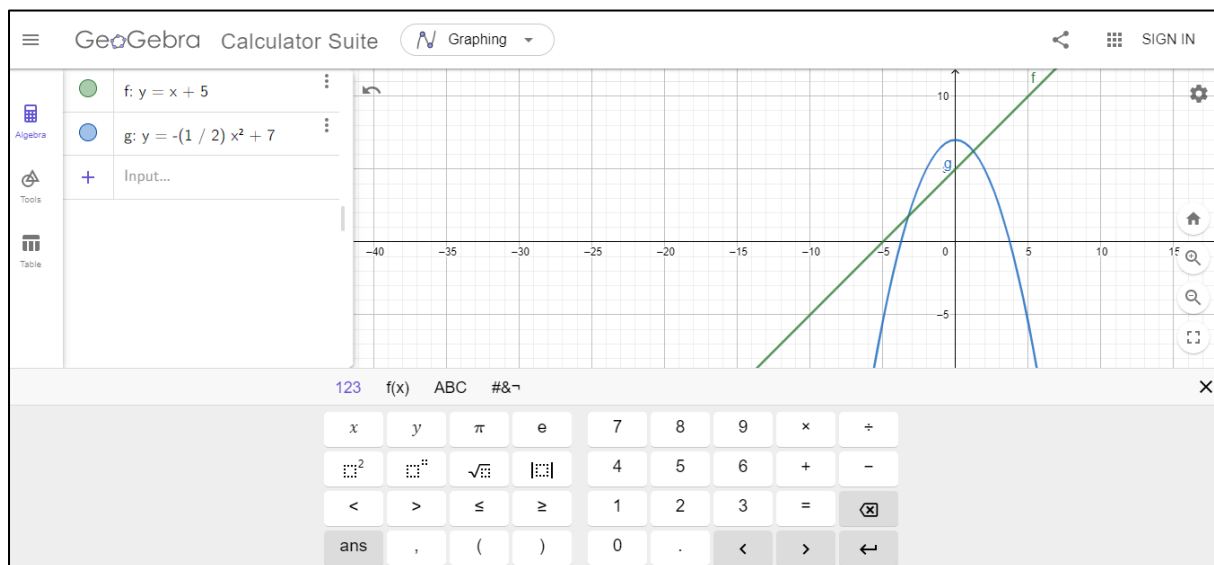



Figure 3 : Graph of  $f(x)$  and  $g(x)$

To find the intersection point between two graph, click on the  Tools icon and select Intersect. The intersection points between  $f(x)$  and  $g(x)$  will appear on the graph as shown in Figure 4 and Figure 5.

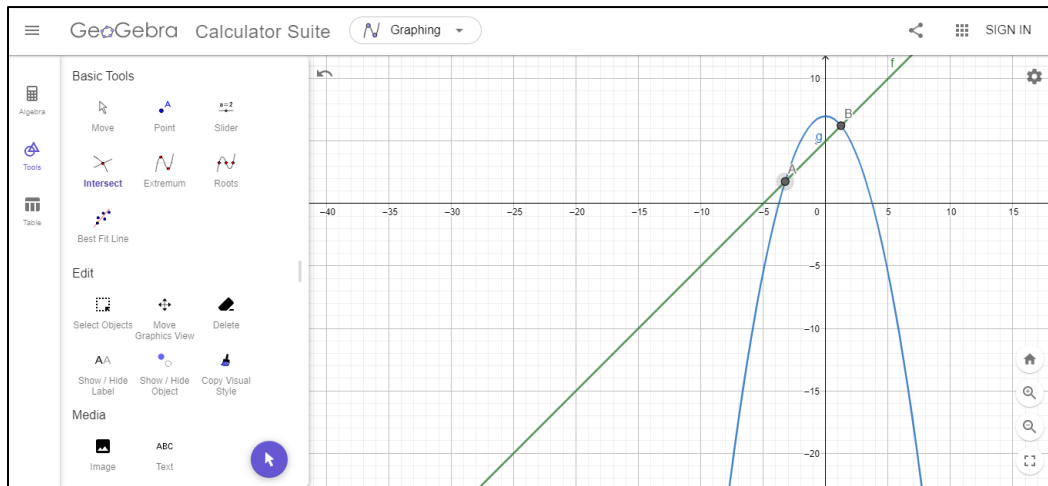


Figure 4 : Intersection point between two graphs

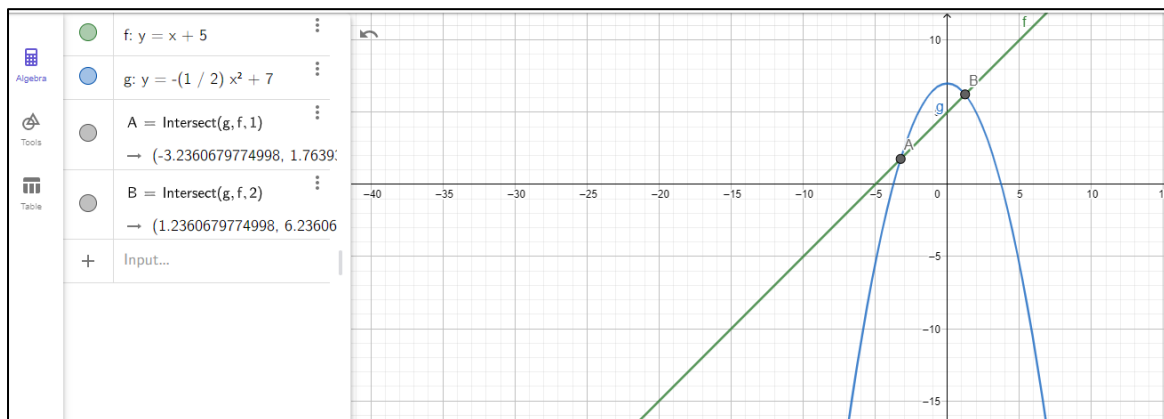


Figure 5 : Intersection point display on the Algebraic View

GeoGebra can also be used to find the derivatives of function by typing the derivative command on the Input Bar as shown in Figure 6 (orange line and purple line).

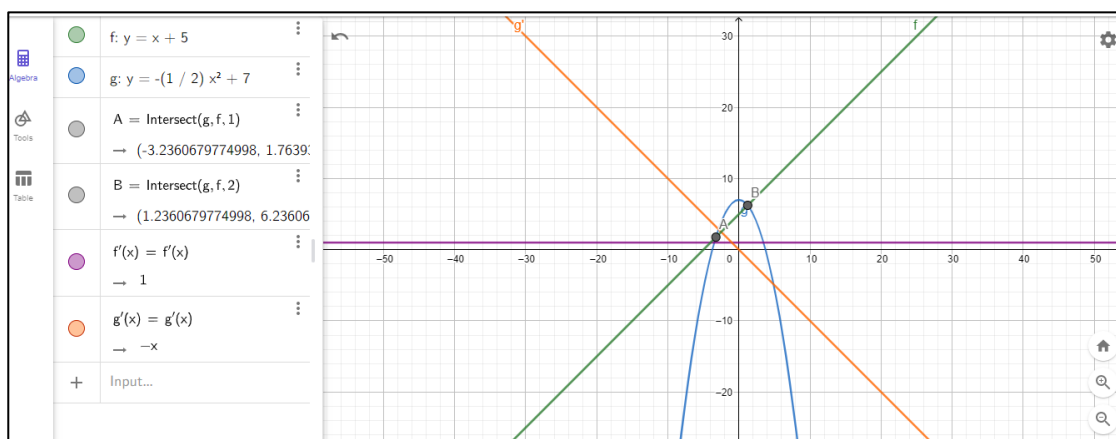


Figure 6: The derivative of  $f(x)$  and  $g(x)$

### Example 2: 3D Function

a) Given a plane  $z = 6$  and cone  $z = \sqrt{4x^2 + 4y^2}$ .

- Sketch the graph of both functions.
- Find the intersection of two surfaces.

Besides sketching 2D graph, we also can sketch 3D graph by using GeoGebra software. The interface of 3D calculator as shown in Figure 7 below.

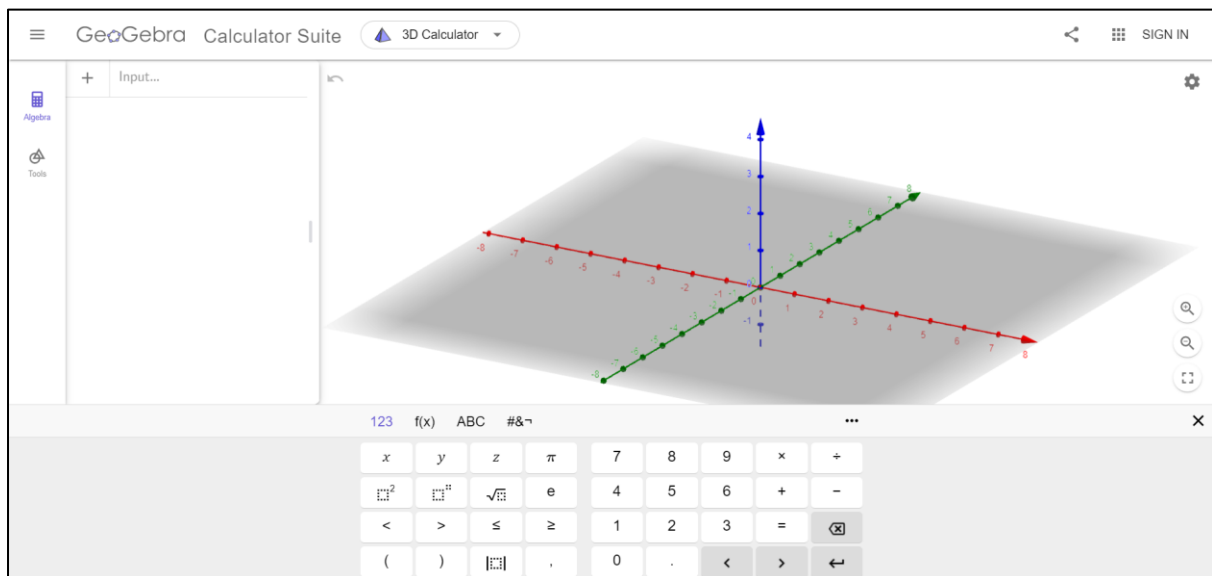


Figure 7: Interface of 3D Calculator in GeoGebra Software

Then, we may type the function in input bar and Figure 8 will show the solid bounded by both functions.

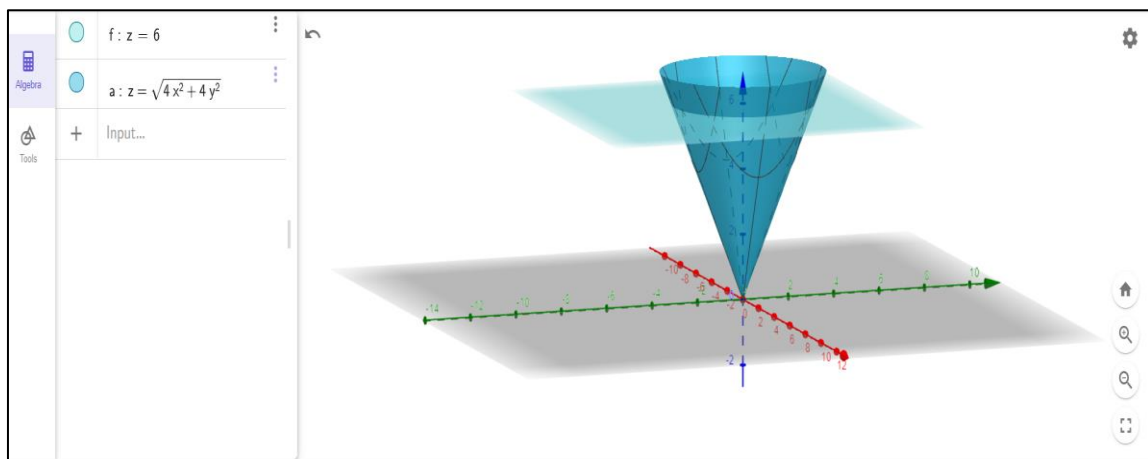


Figure 8: Graph of solid  $z = 6$  and cone  $z = \sqrt{4x^2 + 4y^2}$

Next, to find the intersection of two surfaces, click on the Tools icon and select Intersect Two Surfaces and the result as Figure 9 below.

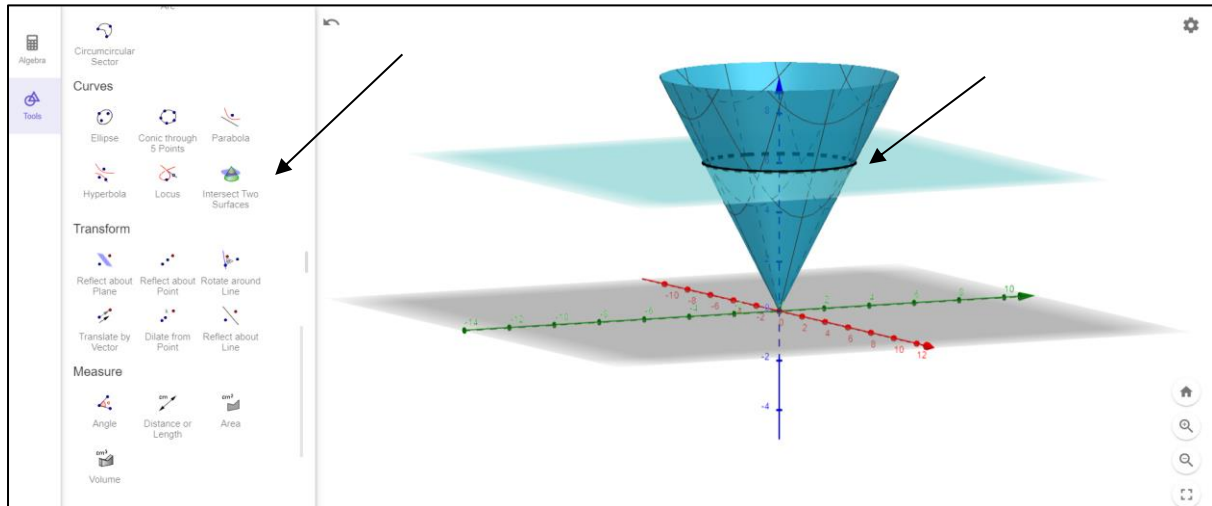


Figure 9 : Intersection between two surfaces

b) Find the volume of sphere  $x^2 + y^2 + z^2 = 36$ .

By typing the equation in the input bar, the sphere will appear as shown in Figure 10 below.

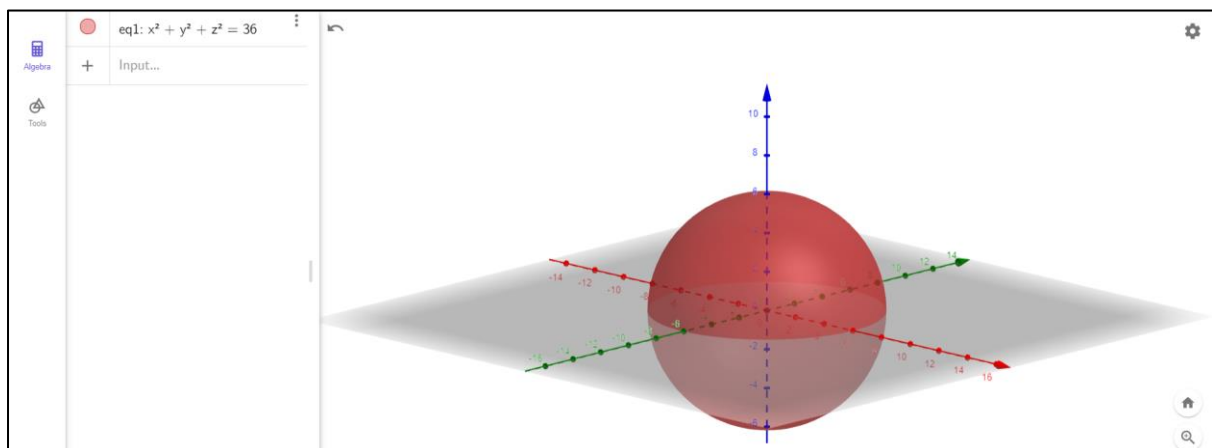


Figure 10: Sphere with radius 6

Beside putting the equation manually, we also can click the tools icon and select the solid that we want as shown in Figure 11 below. Next, we just select the center point and insert the radius of the sphere. The result will show same as in Figure 10 above.

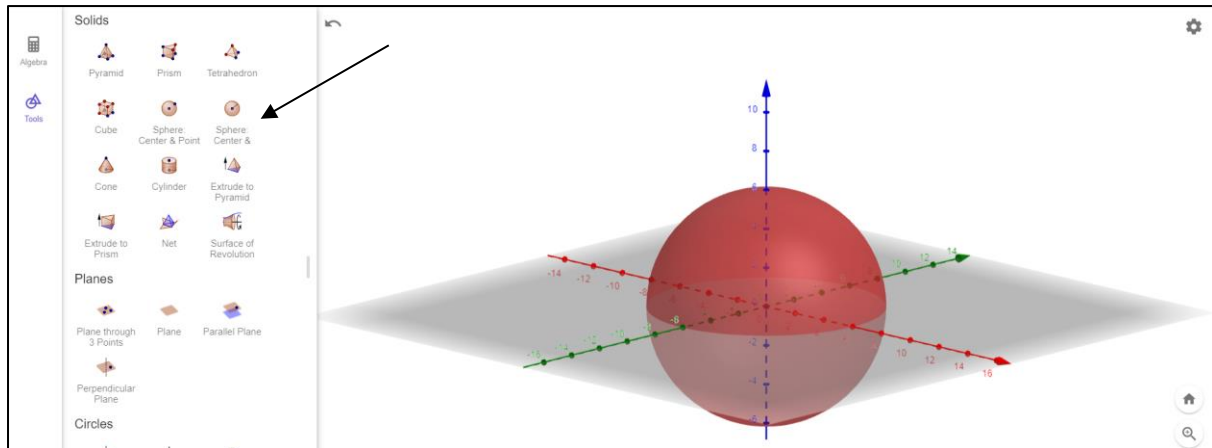


Figure 11: Insert sphere using tools icon

Next, to find the volume of sphere, click on the tools icon again and click volume at measure part. Then, the volume of sphere is shown as Figure 12 below.

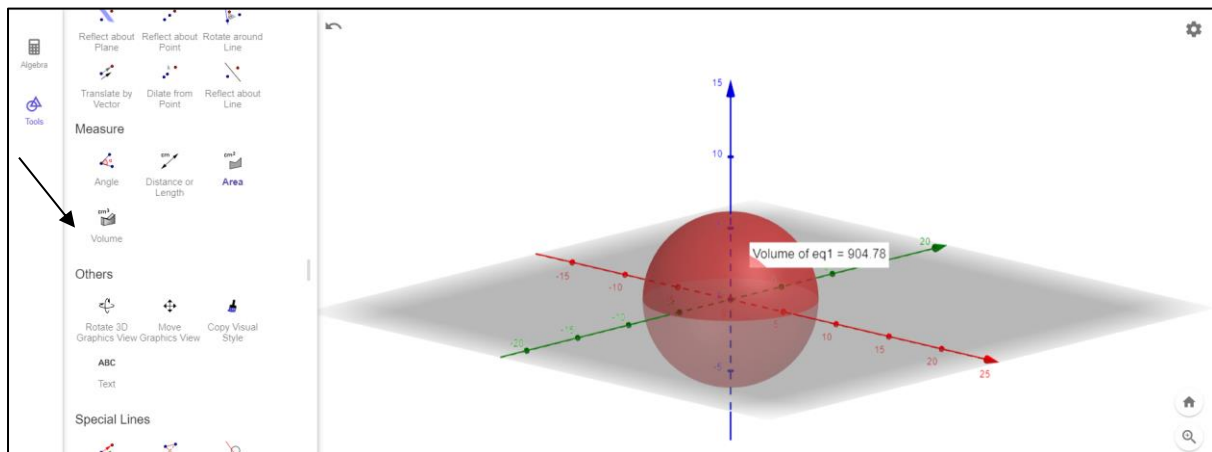


Figure 12: Volume of sphere with radius 6

## Conclusion

In this work, we showed the step by step methods on using GeoGebra as a great tool to help visualised any graphs, either two or three dimensional graphs. It has proven to be a useful tool to enhance students' understanding in solving mathematical problems through assisting them in sketching graphs. This would improve their skills in completing the solution on mathematical problems, particularly in some topics in calculus. Instructors on the other hand,



could benefit from this tool as a teaching aid to make mathematical teaching more visualise and interactive. As it is a free software, it is convenient to use at anytime and anywhere during teaching period. Instructors can also encourage the students to independently use and explore the software on their own as it will help them to engage during the teaching and learning. Therefore, hopefully Instructors could make used of most mathematical apps available in order to improve their teaching and learning.

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