

The use of Geogebra software in teaching mathematics

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Abstract. The development and presence of computer technology have opened opportunities and made it easy for many parties to use it in various aspects of life, including in the world of education, as a tool and means of supporting education. One computer program that can be used in mathematics learning is Geogebra software. Geogebra is a computer program to support teaching and learning mathematics subject, especially in geometry, algebra, and statistics. The various facilities provided by Geogebra software expect that it can be a great media to help its users visualise abstract geometric objects quickly, accurately, and efficiently. Furthermore, this article provides a brief description of Geogebra software as a medium for teaching mathematics. This article is library research. Here, the researcher uses the documentation method to collect data and then analyse the data gathered using content analysis. After analysed twelve related articles which revealed the advantages of using Geogebra in learning mathematics, it is found there are several significant results obtained. These findings, including Geogebra, ease students to comprehend geometry. Students also tend to be happier in learning geometry by using Geogebra, which operated by using a computer.

1. Introduction

The rapid developments of technology require education always to adjust to improve education quality. These demands affect the education field; it involves teacher innovation and creativity in implementing learning by developing a technology-based, student-oriented learning system, and facilitating student needs. However, the fact reveals that students' mathematics learning outcomes lack optimal [1], so that the development of technology can be utilised to enhance learning outcomes. In this case, a computer with various applications, web-based, or related software can be used.

Following the issues above, various computer programs or software can be used to support learning mathematics. The most important thing is that teachers must have sufficient knowledge of insight and skills to operate the software. They can choose sufficient software to support their teaching. One computer program used as a medium for learning mathematics in schools is the *Geogebra* software. The utilising of *Geogebra* software, the abstract geometric objects can be visualised and manipulated quickly, accurately, and efficiently [2].

Furthermore, *Geogebra* software has been translated into various languages (around 73 languages), including the Indonesian language. It is free software that can be downloaded in <http://www.Geogebra.org/>, as the official website. Therefore, one of the most recommended ones is *Geogebra* software. *Geogebra* software frequently uses in mathematics majors, especially for teaching *Geometry* and *Algebra* [3].

This software provides various menu, so that can be used as one of the recommended media for learning mathematics, significantly to demonstrate or visualise mathematical concepts and as a tool to



construct mathematical concepts. The previous research already proves that students' skills and responses were improved after learning geometry by using Geogebra [4]. This finding also reinforced by another study which found that students' understanding categorised as very good when learning with Geogebra [5]. In the other hand, there was a significant advancement of students' mathematical skill after obtained geometry comprehension through the implementation of Geogebra [6]. Moreover, during geometry learning by using Geogebra, students can perform a positive attitude and improve their mathematical problem solving [7]. Geogebra also guides students to better understand geometry concepts compared to learning without Geogebra [8]. Based on the previous study, it can be seen that the using of algebra in learning mathematics, particularly Geogebra, contribute positively toward students' comprehension. Based on the information mentioned above, this article aims to provide a brief description of the concept of *Geogebra* software in teaching mathematics and how it can be used as an excellent tool to facilitate students learning.

2. Methods

This article is a literature review focusing on the advantages of using Geogebra in learning mathematics. The selected articles are sorted from reputable sources and emphasise the successful learning of mathematics supported by utilising Geogebra. Moreover, the reputable resources then analysed by following these steps: (1) identified articles which explained about the advantages of using Geogebra in mathematics learning, (2) investigated the specific benefits of using Geogebra in learning mathematics, (4) grouped the similar benefits by using Geogebra in learning mathematics. By implemented those steps, researchers become more comfortable to arrange this literature review.

3. Results

There are several significant findings resulted from this literature review:

3.1. *Geogebra software*

Geogebra software is highly recommended for both teachers and students to teach and learn specific topics [3]. Unlike other commercial software that can limited access during schools' time, Geogebra can be installed on personal computers and allows its users to get connected anytime and anywhere easily. For teachers, *Geogebra* software offers a valuable opportunity to create interactive online learning environments that enable students to have various ways to explore the mathematical concepts taught. They also added that *Geogebra* software could be truly useful in dealing with the following activities: Demonstration and visualisation media; Construction aids; and Discovery aid.

Taking these issues further, *Geogebra* software has several benefits as a supporting tool in learning mathematics, as presented below [2].

1. Geometry drawings can be made quickly and accurately instead of using a pencil, ruler, or compass.
2. Students can easily understand geometry by using the animation features and virtual displays in the *Geogebra* software so that students get real visual experience.
3. Students' painting result can be used as corrective feedback or evaluation to ensure its correctness.
4. The properties that apply to a geometric object can be investigated by the teacher or students quickly.

3.2. *Applications of Geogebra Software*

The following are several examples of the use of *Geogebra* software in teaching mathematics in schools.

3.2.1. *Application of Geogebra Software in Statistics Material.* Geogebra software can be used in school statistics materials, Geogebra, and statistics materials to be more comfortable for students to understand. The following is an example of school statistics questions that are carried out using Geogebra software:

The data: 20 20 45 23 34 35 40 40 22 43 34 20 30

Find: Mean, Median and Mode.

This following explanation is how to work with *Geogebra* software. Here are the steps:

1. Type the above data on the Input Bar menu:

- Mean (20, 20, 45, 23, 34, 35, 40, 40, 22, 43, 34, 20, 30) then press enter;
- Median (20, 20, 45, 23, 34, 35, 40, 40, 22, 43, 34, 20, 30) then press enter;
- Mode (20, 20, 45, 23, 34, 35, 40, 40, 22, 43, 34, 20, 30) then press enter;

2. If you follow all the steps correctly, Geogebra will display the calculation of the Mean, Median and Mode, as follows:

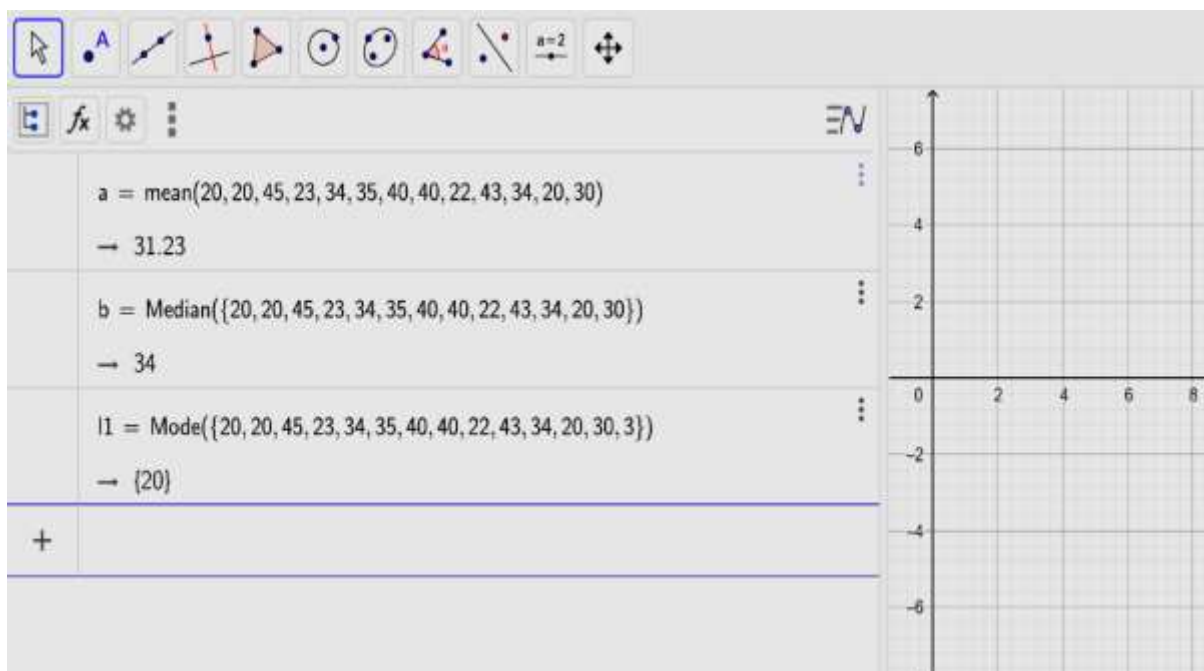


Figure 1. Display of the calculation of the Mean, Median, and Mode.

3.2.2. *Application of GeoGebra Software on Geometry Materials.* The use of Geogebra software aims to describe various geometric shapes. The following is how to Determine the Equation of a Straight Line which is done using GeoGebra software:

Find the line's equation through points A (3, 5) and B (-2, -4).

Here are steps by using *Geogebra* software:

1. In Bar Input mode, type A = (3, 5) then press then enter key, type B = (- 2, -4) then press enter, type the line [A, B] then press enter.
2. Next will form a line and at the same time, the equation on the left side of the graph, the line equation is $9x - 5y = 2$.

If you follow the steps correctly, it will look like this:

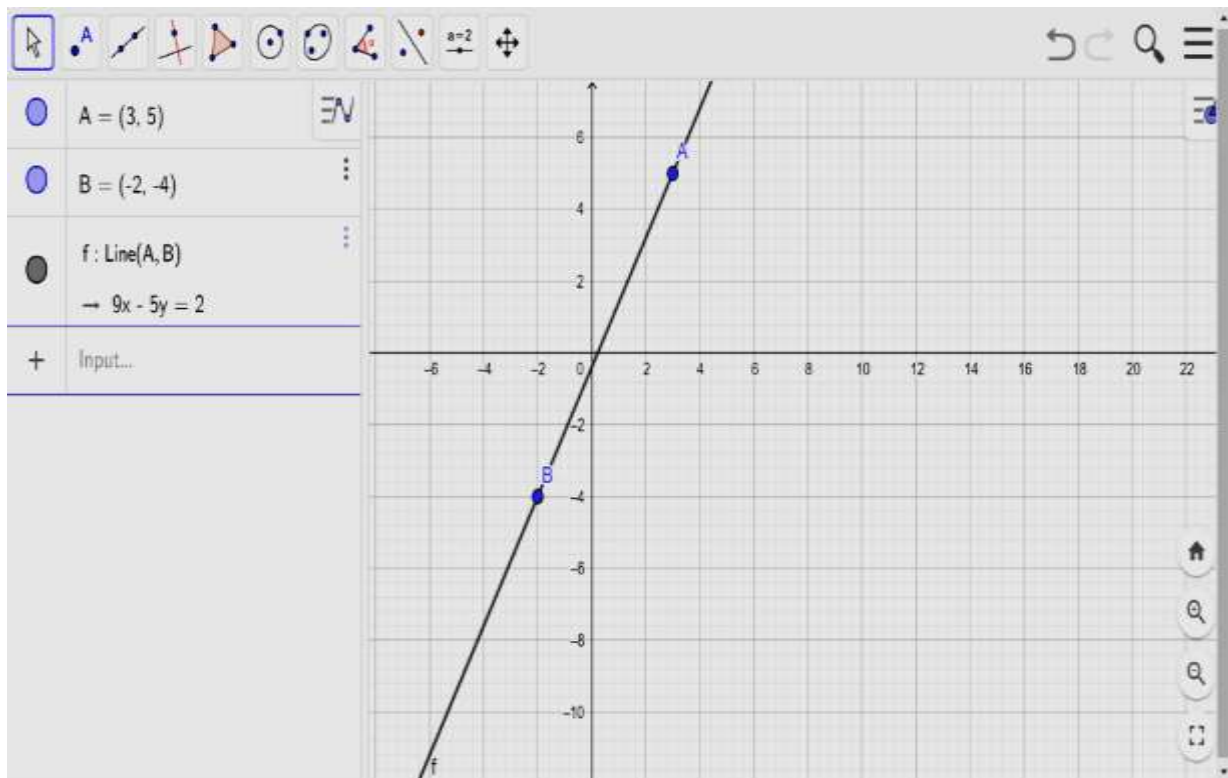


Figure 2. Display of plotting line in GeoGebra

3.3. Supporting Researches

The use of *Geogebra* in learning has received a positive response from most teachers at any education level. As a result, it is one of the most recommended software applied as an innovative way of teaching mathematics supported by technology [9]. In line with these findings, another research also found that many students have positive perceptions of using *Geogebra* software, enhancing students' learning outcomes [10]. Besides, most students show a high interest in learning using *Geogebra* software since it promotes their understanding of the taught concepts [11]. Not only to mention, but it also enhances students' mathematical communication skills on geometry material [12]. Furthermore, the use of *Geogebra* in learning also effectively results in teachers-students interaction during the lesson [13]. Utilising *Geogebra* in mathematics also ease the learning process by providing visualisation that is simple to use and equipped with rich content [14]. Moreover, another research also found that students who learn geometry by using *Geogebra* tend to comprehend the topic more than students who learn geometry without *Geogebra* [15]. This finding also reinforced by another research that proof e-learning using *Geogebra* successfully increases students' comprehension in geometry [16].

Nowadays, researchers have been researching to find the advantages of utilising *Geogebra*. One of that research found several benefits achieved using *Geogebra*, including easy to use by students independently, equipped with attractive animations and images, and provided a simple experiment [17]. This fact is also supported by other result research that proves that *Geogebra* facilitates students to understand geometry [18] better. The latest study also found that *Geogebra* affected students' interest and enjoyment in learning mathematics with the computer. However, students with lower literacy in using the computer was struggling to operate *Geogebra* [19]. Following elaboration, a highly recommends using *Geogebra* software in mathematics teaching and learning process since many kinds of research shows it improves students' understanding of the lesson taught [20].

The learning process by using *Geogebra* in geometry topic is has been investigating by many researchers. The continues researches conducted to examine the positive impact of using *Geogebra* in learning. By implementing *Geogebra* in learning geometry, students can promote their proficiency and

perception [4]. Another research also strengthened students' level of comprehension classified as very good if delivering by using Geogebra [5]. Hence, students' mathematical skill accomplished very well after learned geometry through Geogebra software [6].

Furthermore, during the learning process of geometry by utilising Geogebra, students show a positive attitude and capable of promoting their mathematical problem solving [7]. Geogebra also leads students to understand better geometry concepts than learning geometry without Geogebra [8]. Another research proved that learning with utilising Geogebra also categorised as an effective process [21]. Another analysis also revealed that the use of Geogebra successfully promotes student geometrical studies [22]. Other research also reinforced this obviousness by stating that the use of Geogebra in learning geometry significantly affected students' mathematical comprehension [23]. According to those findings, it can be inferred that the utilising of Geogebra in learning mathematics, particularly in geometry have a significant and positive impact to promote students' comprehension.

4. Conclusion

The utilising Geogebra in learning mathematics has several positive impacts, including: (1) Geogebra is a great tool to improve the quality of learning, particularly to explore, visualise, and construct mathematical concepts, (2) It enhances students' mathematical abilities such as mathematical proof abilities, mathematical reasoning abilities, and mathematical problem-solving abilities, and (3) Geogebra is genuinely useful for both students and teachers, and it is easy to use and can easily access from anywhere and anytime. Several recommendations for further research to comprehensively depict the real phenomenon of utilising Geogebra software during the lesson. It is recommended that future researcher use quasi-experimental research to be critically examined, and the solution will be more meaningfully. Teachers have to make sure that they have sufficient knowledge and skill in operating this software so that they can use it efficiently. The last recommendation is for students to regularly utilise this software to enhance their capability and minimise the confusion when operating Geogebra software.

References

- [1] Soetadiana W 2014 *Pengembangan Perangkat Pembelajaran Kontekstual Dengan Menggunakan software Geogebra Versi 4.4 Pada Materi Lingkaran untu kelas VIII Siswa SMP* (Universitas Negeri Surabaya)
- [2] Mahmudi A 2010 *Membelajarkan Geometri dengan Program Geogebra Seminar FPMIPA UNY* (Yogyakarta) pp 1-2
- [3] Hohenwarter M and Fuchs K 2004 *Combination of Dynamic Geometry, Algebra, and Calculus in the Software System Geogebra* (<https://pdfs.semanticscholar.org/137b/7e90b60215b97afa4fd3fa0edada3ec167b8.pdf>)
- [4] Ridha M R and Pramiarsih E E 2020 The Use of Geogebra Software in Learning Geometry Transformation to Improve Students' Mathematical Understanding Ability In *Journal of Physics: Conference Series* vol 1477 (IOP Publishing) pp 042048
- [5] Condori A P, Velazco D J M and Fernández R A 2020 November Geogebra as a Technological Tool in the Process of Teaching and Learning Geometry In *Conference on Information and Communication Technologies of Ecuador* (Springer, Cham) pp 258-71
- [6] Kusumah Y S, Kustiawati D, and Herman T 2020 The Effect of Geogebra in Three-Dimensional Geometry Learning on Students' Mathematical Communication Ability *Int. J. Instr.* **13** 895-908
- [7] Septian, A, Inayah S, Suwarman R F and Nugraha R. 2020 August Geogebra-Assisted Problem Based Learning to Improve Mathematical Problem Solving Ability In *SEMANTIK Conference of Mathematics Education (SEMANTIK 2019)* (Atlantis Press) pp 67-71
- [8] Jelatu S 2018 Effect of Geogebra-Aided REACT Strategy on Understanding of Geometry Concepts *Int. J. Instr.* **11** 325-36

- [9] Zakaria E and Lee L S 2012 Teacher's perceptions toward the use of Geogebra in the teaching and learning of Mathematics *J. Math. Stat.* **8** 253-7
- [10] Shadaan P and Leong K E 2013 Effectiveness of Using Geogebra on Students' Understanding in Learning Circles *Malaysian Online J. Educ. Technol.* **1** 1-11
- [11] Sudihartinih E and Purniati T 2019 February Using Geogebra to develop students understanding on circle concept In *J. Phys. Conf. Ser.* **1157** p 042090
- [12] Kusumah Y S, Kustiawati D and Herman T 2020 The Effect of Geogebra in Three Dimensional Geometry Learning on Students' Mathematical Communication Ability *Int. J. Instr.* **13** 895-908
- [13] Zulnaldi H, Oktavika E and Hidayat R 2020 Effect of use of Geogebra on achievement of high school mathematics students *Educ. Inf. Technol.* **25** 51-72
- [14] Yorganci S 2018 A study on the views of graduate students on the use of Geogebra in mathematics teaching *Eur. J. Educ. Stud.*
- [15] Japa N, Suarjana I M and Widiiana W 2017 Media Geogebra Dalam Pembelajaran Matematika *Int. J. Nat. Sci. Eng.* **1** 40-7
- [16] Sudihartinih E and Wahyudin W 2019 Pembelajaran Berbasis Digital: Studi Penggunaan Geogebra Berbantuan E-Learning Untuk Meningkatkan Hasil Belajar Matematika *J. Tatsqif* **17** 87-103
- [17] Saputra E and Fahrizal E 2019 The Development of Mathematics Teaching Materials through Geogebra Software to Improve Learning Independence *Malikussaleh J. Math. Learn* **2** 39-44
- [18] Alkhateeb M A and Al-Duwairi A M 2019 The Effect of Using Mobile Applications (Geogebra and Sketchpad) on the Students' Achievement International Electronic *J. Math. Educ.* **14** 523-33
- [19] Celen Y 2020 Student Opinions on the Use of Geogebra Software in Mathematics Teaching *Turkish Online J. Educ. Technol.* **19** 84-8
- [20] Jelatu S 2018 Effect of Geogebra-Aided REACT Strategy on Understanding of Geometry Concepts *Int. J. Instr.* **11** 325-36
- [21] Muslim M and Haris A 2017 October Keefektifan Model Pembelajaran Kooperatif Tipe Group Investigation pada Materi Geometri Berbantuan Geogebra Ditinjau dari Kemampuan Representasi Matematika dan Self-Efficacy In *Prosiding Seminar Nasional Pendidikan dan Pengembang Pendidikan Indonesia* pp 438-46
- [22] Seloraji P and Eu L K 2017 Students' Performance in Geometrical Reflection Using Geogebra *Malaysian Online J. Educ. Technol.* **5** 65-77
- [23] Kustiawati D 2016 Pembelajaran Geometri Berbantuan Software Geogebra Terhadap Kemampuan Komunikasi Matematik Siswa *JIPMat* **1**

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