

Using GeoGebra for Mathematics Learning: Literature Review on Solving Linear Equations in Two Variables

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ABSTRACT

This article explores the use of GeoGebra as a tool in learning mathematics, especially for the topic of solving linear equations in two variables. Using the literature review method, this article analyzes various studies that examine the effectiveness of GeoGebra in improving students' understanding of this material. The review results show that GeoGebra can facilitate understanding of mathematical concepts in a more visual and interactive way, although its implementation requires careful instructional design. This article concludes that GeoGebra is a useful tool for learning linear equations in two variables by providing significant benefits in conceptual understanding and student engagement.

Keywords: Geogebra, Mathematics Learning, Literature Review, Solving Linear Equations in Two Variables.

INTRODUCTION

Solving linear equations in two variables is one of the basic concepts of algebra that is important for students to understand. (Islamiyah, Prayitno, & Amrullah, 2018). In the concept of linear equations of two variables, students learn to compose a system of linear equations of two variables from everyday problems and determine their solutions. Students experience some difficulties in this topic due to a lack of understanding of the concept of linear equations of two variables. (Yuliana, Sanusi, & Maharani).

In learning mathematics, there are several concepts that must be mastered by students, one of which is the concept of linear equations of two variables. This is because linear equations of two variables are related to the concepts that will be studied in the next topic. The concept of linear equations of two variables requires students to have a mathematical understanding, namely the ability to interpret and transform stories into mathematical equations. (Takalao, Regar, & Sulistyarningsih, 2022).

The system of linear equations of two variables requires students to have an understanding of the concept. In solving linear equations of two variables, it can be done using graphical methods, elimination, substitution, and a combination of elimination and substitution methods. (Simanjuntak, Sinaga, Panjaitan, & Manik, 2023). To solve a linear equation of two variables, you can use one of the methods that you have mastered. Each student has their own considerations in using the method that will be used to solve a linear equation of two variables..

As technology advances, many software are available that can be used in education. The available technology can help students' understanding in various subjects, including Mathematics. Mathematics is a subject that is considered abstract and requires reasoning to understand it, so the presence of technology can help students to better understand Mathematics lessons. One of the educational software that can be used is GeoGebra (Gusteti, et al., 2023). GeoGebra is a web-based software that can be used for free in the learning process..

GeoGebra is an interactive mathematics software that allows students to explore and understand mathematical concepts visually. (Siregar, Pulungan, Thahara, & Dalimunthe, 2023). Visual presentation of mathematical concepts can help students to understand Mathematics lessons. Visual presentation allows students to have a better understanding. This literature review aims to evaluate how GeoGebra can be used to teach solving linear equations in two variables and identify the benefits and challenges of its use.

LITERATURE REVIEW

GeoGebra is an open-source software tool that integrates geometry, algebra, and calculus in one platform. Research by Siregar et al. (2023) shows that GeoGebra can improve students' understanding of mathematical concepts through better visualization and interaction. GeoGebra allows students to build graphical representations of abstract mathematical concepts, which can help in understanding relationships between variables. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables.

GeoGebra can be used in learning that involves students with diverse abilities. (Siregar, et al., Penerapan Aplikasi Geogebra pada Pembelajaran Matematika, 2023). Students with poor math skills can understand easily if learning is presented visually. Students can do simulations so they can understand the relationship between variables. The simulation in question is by changing the elements in a two-variable linear equation. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables.

Linear equations in two variables are an important topic in algebra that is often taught in high schools. Research by Siregar et al. (2023) shows that graphic visualization can help students understand solutions to systems of linear equations better. GeoGebra, with its ability to visualize graphs of equations, can support this process. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables.

Linear equations of two variables require students to have critical thinking skills. (Arifanti, Raupu, & Thalha, 2021). Students are expected to be able to understand story problems related to linear equations of two variables. Based on the story problem, students are expected to be able to change it into a mathematical equation and solve it. There are several ways to solve linear equations of two variables. The methods in question are graphical, elimination, substitution, or a combination of elimination and substitution. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need a mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

Several studies show that GeoGebra can improve students' understanding and skills in mathematics. Jelatu et al. (2018) suggest that GeoGebra allows students to explore mathematical concepts dynamically and interactively, which has the potential to improve their conceptual understanding. Students can explore independently or in groups. This allows students to understand more thoroughly. GeoGebra offers a feature that allows students to see a graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

Meanwhile, Oktaria et al. (2020) reported that the use of GeoGebra in learning linear equations in two variables helps students understand the relationship between graphs and algebra.

METHODS

This research is a literature review research. Literature Review is a library research conducted by reading various library sources related to the research topic. (Abraham & Supriyati, 2022). The various sources of literature referred to can be books, journals, and other publications. The selected literature is one that meets the following criteria.:

1. **Relevance:** Study that discusses the use of GeoGebra in the context of learning linear equations in two variables. GeoGebra can be used for learning mathematics in various concepts, so it is necessary to limit it to make it easier to carry out this research. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables. GeoGebra can be used for learning mathematics in various concepts, so it is necessary to limit it to make it easier to carry out this research. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.
2. **Quality:** Studies published in leading academic journals or conferences. The literature related to GeoGebra and linear equations in two variables is quite extensive, so it is necessary to limit it so that it will be easier to conduct this research. GeoGebra offers a feature that allows students to see the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need a mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables. The literature related to GeoGebra and linear equations in two variables is quite extensive, so it is necessary to limit it so that it will be easier to conduct this research. GeoGebra offers a feature that allows students to see the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need a mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables.
3. **Methodology:** Studies that use valid and reliable research designs. Research related to GeoGebra and two-variable linear equations is widely available, but not all of them use good and correct methodology. This causes the need to make limitations by selecting articles that use good and correct methods. GeoGebra offers a feature that allows students to view graphs of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations. Research related to GeoGebra and two-variable linear equations is widely available, but not all of them use good and correct methodology. This causes the need to make limitations by selecting articles that use good and correct methods. GeoGebra offers a feature that allows students to view graphs of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations.

All libraries used can be accessed freely and free of charge for research and education purposes. This aims to avoid the need to use data in searching for various libraries in conducting research.

RESULTS AND DISCUSSION

The literature review identified several key findings regarding the use of GeoGebra in learning linear equations in two variables. What is meant is as follows:

Graphic Visualization: GeoGebra helps students understand the concept of linear equations in two variables by visualizing graphs and solutions of systems of equations (Cahyasari, Irbah, Aisyah, & Faradila, 2024). The graphs generated by GeoGebra can help students understand abstract

mathematical concepts. This can help students who have low mathematical abilities. Students who have low mathematical abilities often find it difficult to learn abstract mathematical concepts (which require conceptual understanding). GeoGebra offers a feature that allows students to see the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables. The graphs generated by GeoGebra can help students understand abstract mathematical concepts. This can help students who have low mathematical abilities. Students who have low mathematical abilities often find it difficult to learn abstract mathematical concepts (which require conceptual understanding). GeoGebra offers a feature that allows students to see the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables

Interaction and Exploration: GeoGebra's interactive features allow students to experiment with changing variables and see their effects directly, which supports better understanding (Langi, Tumulun, & Regar, 2024). Changes in each variable can cause differences in the graph. So by changing the variables, students can understand the impact that occurs on the graph. This causes students to be able to understand the variables in a two-variable linear equation better. GeoGebra offers a feature that allows students to see the graph of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations. Changes in each variable can cause differences in the graph. So by changing the variables, students can understand the impact that occurs on the graph. This causes students to be able to understand the variables in a two-variable linear equation better. GeoGebra offers a feature that allows students to see the graph of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations

Increased Engagement: GeoGebra can increase student engagement in mathematics learning by providing a more dynamic and interesting learning environment (Arslan & Yıldırım, 2020). GeoGebra presents graphs with attractive and varied colors, so that students have more interest in learning. Changes in equations can cause changes in existing graphs. This certainly attracts students' interest in understanding the concept of equations and existing graphs. In manual learning, teachers only explain abstractly to students. This certainly makes it difficult for students who have low mathematical abilities. GeoGebra offers a feature that allows students to see graphs of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need a mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations.

The review results show that GeoGebra can improve students' understanding of solving linear equations in two variables by providing a clear and interactive visual representation. GeoGebra allows teachers to provide better and more interesting visualizations. Some teachers have good skills in drawing graphs on the board, but this certainly takes more time. GeoGebra can display graphs in a short time, even if there is a change in the equation elements, the graph will adjust to the changes that have been made. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

However, the effectiveness of GeoGebra depends greatly on how the software is applied in a learning context. Mathematics learning using GeoGebra that is not in accordance with the context can confuse students. The learning context used must be in accordance with the learning concept being studied. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

Teachers need to design activities that make optimal use of GeoGebra features to ensure maximum benefits. The teacher's ability to use GeoGebra depends on the time spent by the teacher in preparing the lesson. The more often the teacher uses GeoGebra, the more the teacher's ability to use it will increase. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

Additionally, some studies suggest that technical difficulties and lack of training may hinder the effective use of GeoGebra in the classroom. GeoGebra training is widely available for free on the internet. This certainly makes it easier for teachers to access the training in question without having to spend money. The more often teachers access GeoGebra training, the more proficient they will be in using GeoGebra. GeoGebra offers a feature that allows students to view graphs of a two-variable linear equation. Two-variable linear equations can be obtained from story problems related to two-variable linear equations. Students need a mathematical understanding to obtain two-variable linear equations from story problems related to two-variable linear equations. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables.

CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

GeoGebra is a useful tool in learning linear equations in two variables, especially in terms of visualization and interactions that support understanding of concepts. By utilizing GeoGebra's interactive features, students can gain a better understanding of graphing linear equations and solutions to systems of equations. However, effective implementation requires careful instructional design and training support for teachers. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables.

Using GeoGebra in mathematics education can provide significant benefits if used in the right way. The implications of the results of this review include:

1. **Technology Integration:** Integrating GeoGebra in the mathematics curriculum to increase conceptual understanding and student engagement. The use of GeoGebra can also facilitate the learning process. Students can also understand more easily if learning is displayed visually. GeoGebra offers a feature that allows students to see graphs of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need a mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.
2. **Teacher Training:** Providing training for teachers so they can utilize GeoGebra effectively in the learning process. Teachers who have practiced a lot will find it easier to use GeoGebra. GeoGebra offers a feature that allows students to see the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables.
3. **Activity Design:** Develop learning activities that utilize GeoGebra features to support student exploration and understanding. Students who learn visually and practice directly

will have a better understanding. GeoGebra offers a feature that allows students to see the graph of a linear equation of two variables. Linear equations of two variables can be obtained from story problems related to linear equations of two variables. Students need mathematical understanding to obtain linear equations of two variables from story problems related to linear equations of two variables.

Conduct further studies to explore the impact of GeoGebra in other mathematics learning contexts and for different groups of students. Researching ways to develop more specific GeoGebra features to support mathematics learning. Examining the effectiveness of GeoGebra implementation in various educational settings to understand different challenges and successes. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables.

This research includes only published studies, and may not include the latest research or relevant data. Findings may not be generalizable to all learning contexts or student populations. The focus of this article is limited to using GeoGebra for the topic of linear equations in two variables and does not cover other applications of GeoGebra. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. Linear equations in two variables can be obtained from story problems related to linear equations in two variables. Students need mathematical understanding to obtain linear equations in two variables from story problems related to linear equations in two variables. GeoGebra offers a feature that allows students to view the graph of a linear equation in two variables. A linear equation in two variables can be obtained from a story problem related to a linear equation in two variables. Students need mathematical understanding to obtain a linear equation in two variables from a story problem related to a linear equation in two variables.

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