

## Application of Geogebra in Mathematics Learning Using a Realistic Mathematics Education Model

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**Abstract:** The application of GeoGebra in teaching still faces challenges such as teacher readiness and the availability of technology in schools, especially in mathematics learning. This research examines the correlation of the GeoGebra application to the mathematics learning outcomes of students whose learning uses the Realistic Mathematic Education learning model. This research was conducted at SDN 074 Ayudia, Bandung City using quantitative methods with a non-experimental approach. The population in this study were all students at SDN 074 Ayudia with a sample of 27 students in class VI B and the instruments used were questionnaires and tests. The sampling technique was carried out using a probability sampling technique based on cluster sampling. Meanwhile, the swimmer test from the data analysis carried out was a normality test using Kolmogorov-Smirnov assisted by the SPSS application. In this research, it can be concluded that there is no significant correlation between the application of Geogebra to the mathematics learning outcomes of students whose learning uses the Realistic Mathematic Education (RME) model, and the correlation is classified as very low. For further research, it is hoped that we can use other learning models to see the influence that occurs between the application of the Geogebra application in mathematics learning to see special equations in simple linear regression to be able to know the probability of the independent variable and the dependent variable.

**Keywords:** Geogebra Application, Mathematics Learning, Realistic Mathematic Education.

### INTRODUCTION

Mathematics is a subject that plays an important role in developing logical, analytical, and creative thinking skills (Al Ayyubi, Bukhori, et al., 2024; Al Ayyubi, Hayati, et al., 2024; Al Ayyubi, Rohaendi, et al., 2024). However, the challenge in mathematics learning often lies in students' lack of conceptual understanding due to less interactive teaching methods. Students



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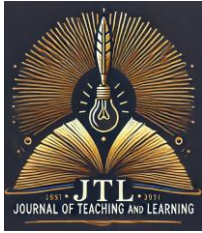
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frequently perceive mathematics as an abstract subject, which can decrease their motivation to learn. This impacts their learning outcomes, which tend to be low in various aspects, such as communication and problem solving skills (Sopanda et al., 2022). The Realistic Mathematics Education (RME) approach emerges as a solution by emphasizing the connection between mathematical concepts and real-world situations (Maulidina, 2023; Nurjamaludin et al., 2021).

This approach aims to make mathematics more relevant to students' lives, thereby motivating them to actively participate in learning. Previous studies have shown that this approach can enhance students' motivation and mathematical abilities, especially when supported by relevant technology such as GeoGebra (Maulidina, 2023). In the context of RME, GeoGebra facilitates the exploration of mathematical concepts in a more intuitive way, allowing students to see the connections between theory and its applications in daily life. Students can test their hypotheses through visual simulations, ultimately helping to improve memory retention and conceptual understanding. Recent studies have found that the integration of GeoGebra with the RME approach not only enhances students' mathematical literacy skills but also provides a more meaningful learning experience (Birgin & Acar, 2022; Birgin & Topuz, 2021; Birgin & Uzun Yazıcı, 2021; Diva et al., 2023; Fathurrahman & Fitrah, 2023). Thus, GeoGebra plays a crucial role in addressing the challenges that students often face when learning mathematics (Nurul, 2024). Students who learn with the GeoGebra-assisted RME approach show significant improvement in their learning outcomes compared to the conventional approach (Jabnabillah & Fahlevi, 2023). GeoGebra allows teachers to present material in a more dynamic way, encouraging students to actively participate and think critically. With the ability to adjust the level of difficulty according to students' needs, GeoGebra can accommodate a wide range of student abilities, from basic to advanced levels. This positive impact is also evident in students' mathematical communication skills, as they find it easier to express their understanding of concepts both visually and verbally (Lestari & Sundi, 2021; Yanti et al., 2019; Zulfikar et al., 2022). This application also provides opportunities for teachers to develop more creative and interactive teaching methods (Rostina et al., 2021).

Despite its many benefits, the implementation of GeoGebra in teaching still faces challenges, such as teachers' readiness and the availability of technology in schools. The lack of training for teachers often becomes a major barrier in maximizing the use of GeoGebra in the classroom



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(Sutrisno et al., 2020). Additionally, some schools, especially in remote areas, still lack the adequate infrastructure to support this technology. As a result, there has been limited research on the implementation of the RME model assisted by GeoGebra in schools that do not have sufficient facilities and infrastructure. Furthermore, there is still a lack of research on the integration of GeoGebra with the RME model at the elementary school level. Therefore, to address the gap in previous research, this study aims to examine the correlation between the application of GeoGebra and students' mathematics learning outcomes when using the RME teaching model. With the correlation found in this study, it is hoped that the application of GeoGebra can be optimized as an effective learning tool at various educational levels, whether using a more focused RME model or other teaching models that can support the application of GeoGebra in mathematics learning (Maulidina, 2023).

## METHOD

This research was conducted at SDN 074 Ayudia in Bandung City using a quantitative method with a non-experimental approach, aimed at exploring the relationship between the independent and dependent variables without establishing causality. The application of GeoGebra is the independent variable, while students' mathematics learning outcomes using the RME teaching model are the dependent variable. The focus is oriented towards examining whether there is a relationship between the application of GeoGebra and students' mathematics learning outcomes, as well as determining the strength of this relationship in learning using the RME model. The population in this study consists of all students at SDN 074 Ayudia, with a sample of 27 students from class VI B. The instruments used were questionnaires and tests. The sampling technique applied was probability sampling based on cluster sampling. The prerequisite test for data analysis was conducted using normality testing with the Kolmogorov-Smirnov test assisted by SPSS. If the data is normally distributed, the analysis continues with parametric statistical testing using Pearson's correlation. However, if the data is not normally distributed, non-parametric statistical testing is conducted using the Spearman test.

## RESULT AND DISCUSSION



## RESULT

The Alternative Hypothesis ( $H_1$ ) and Null Hypothesis ( $H_0$ ) are as follows:

- $H_0$  : There is no correlation between the application of GeoGebra and students' mathematics learning outcomes using the Realistic Mathematics Education teaching model.
- $H_1$  : There is a correlation between the application of GeoGebra and students' mathematics learning outcomes using the Realistic Mathematics Education teaching model.

**Table 1.** Descriptive Statistics

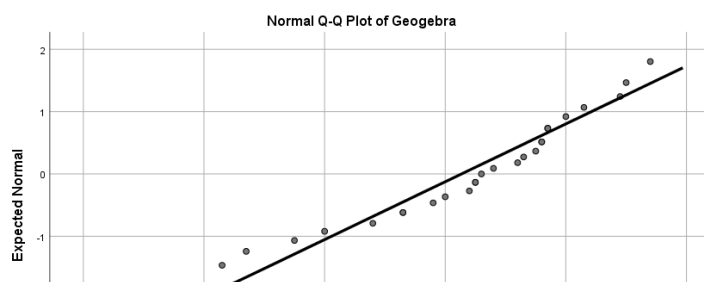
	Mean	Standard Deviation
Geogebra Application	142,7	21,54
Learning outcomes	84,52	3,203

Based on the data in Table 1 above, it is obtained that the mean values for the independent and dependent variables are 142.7 and 84.52, respectively. The standard deviations are 21.54 and 3.203, which were obtained based on a sample of 27 students. Normality testing is then required to determine whether the data comes from a normally distributed population, as this is a prerequisite for inferential statistical testing. In this case, the researcher conducted the normality test based on the Kolmogorov-Smirnov method.

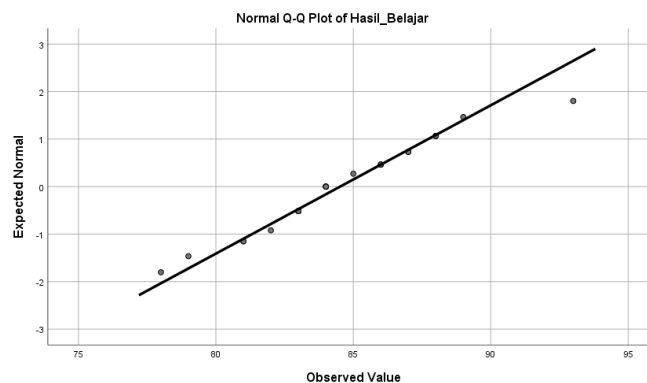
**Table 2.** Tests of Normality

	Statistics	Sig.
Geogebra Application	.154	.102
Learning outcomes	.157	.086

Based on the data in Table 2 above, the significance values for the application of GeoGebra and students' mathematics learning outcomes in the Kolmogorov-Smirnov test are 0.102 and 0.086, respectively. From this data, it can be seen that the significance values are greater than 0.05, so according to the decision criteria,  $H_0$  is accepted, which means that the data is normally distributed. Since the assumption of normality is met, the next test is the Correlation Test using Pearson's test. Additionally, the normality of the data can be observed through the Normal Q-Q plot shown in the figure below.



**Picture 1.** Normal Q-Q Plot of Geogebra



**Picture 2.** Normal Q-Q Plot of Learning Outcomes

In the Normal Q-Q Plot of GeoGebra and Learning Outcomes, the data points are scattered around the diagonal line and closely align with it, indicating that the data can be considered normally distributed.

**Table 3.** Correlations

	Geogebra	Learning Outcomes
Correlation Coef.	1.000	.022
Sig. (2-tailed)		.914
Correlation Coef.	.022	1.000
Sig. (2-tailed)	.914	

Based on the data in Table 3 above, it can be seen that the significance value for the application of GeoGebra on students' mathematics learning outcomes is 0.914. From this data, it is obtained that the significance value is greater than 0.05, so according to the decision criteria,  $H_0$  is accepted.



This indicates that there is no correlation between the application of GeoGebra and students' mathematics learning outcomes using the Realistic Mathematics Education (RME) model. In other words, the use of GeoGebra does not affect the mathematics learning outcomes of students who use the Realistic Mathematics Education (RME) model.

**Table 4.** Correlation Value

<b>Interval Coefficient</b>	<b>Strength of Relationship</b>
0,00 – 0,19	Very Low
0,20 – 0,39	Low
0,40 – 0,59	Moderate
0,60 – 0,79	Strong
0,80 – 1,00	Very Strong

Meanwhile, the value of the Correlation Coefficient in Table 3 above shows a value of 0.022. Based on the interpretation guidelines, it can be stated that the relationship between the application of GeoGebra and students' mathematics learning outcomes using the Realistic Mathematics Education (RME) model is very weak.

## DISCUSSION

Based on the explanation of the results above, the data for the independent and dependent variables, namely the GeoGebra application and students' mathematics learning outcomes, show that the data is normally distributed with a significance value of less than 0.05. Additionally, as seen in the Normal Q-Q plot output, the data points are located around the diagonal line or close to it. Therefore, parametric statistical testing was conducted using Pearson's test. The Pearson test indicates that the correlation or relationship between the use of the GeoGebra application and students' mathematics learning outcomes using the Realistic Mathematics Education (RME) model



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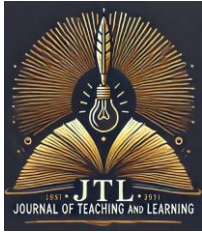
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does not significantly affect learning outcomes, and this relationship is considered very weak. Based on this, it can be concluded that the application of GeoGebra in mathematics learning using the RME model does not provide a significant correlation. However, the correlation is very weak, and further testing with a larger sample could strengthen the results of the significance of the correlation, which is consistent with previous research conducted by Hikmah & Saputra (2022).

GeoGebra is a dynamic mathematics software that supports interactive mathematics learning, including algebra, geometry, statistics, and calculus. The software was developed by Markus Hohenwarter in 2001 and is designed to help students and teachers understand mathematical concepts in a more visual and intuitive way. GeoGebra offers various features such as interactive graphs, manipulation of geometric shapes, and data visualization (Ayu, 2024; Komara, 2023). Here is a breakdown of GeoGebra's key features: (1) Geometry and Graph Visualization; (2) High Interactivity; (3) Multi-platform; and (4) Compatibility with Curriculum.

GeoGebra allows students to see and explore the relationships between mathematical concepts through interactive graphs and geometric shapes. For example, students can observe how changes in one variable of a function affect its graph, or how moving a point on a geometric figure changes its properties. One of GeoGebra's main strengths is the high level of interactivity it offers. Users can directly manipulate mathematical elements in graphs or geometry, such as moving points, changing parameter values in functions, or altering the shape of geometric figures. This allows them to see the real-time effects of these changes, which helps improve understanding of abstract mathematical concepts. GeoGebra can be accessed across various devices, whether computers, tablets, or smartphones, and is compatible with a wide range of operating systems such as Windows, macOS, Linux, Android, and iOS. This makes it easy for students and teachers to access it anytime and anywhere. GeoGebra is designed with the needs of learners at all educational levels in mind, from elementary school to university. The application provides a variety of tools and features that support various mathematical topics taught in the curriculum, such as algebra, geometry, calculus, statistics, and more.

These features make GeoGebra a highly useful tool for supporting a more interactive and visual approach to learning mathematics. GeoGebra allows students not only to view but also to directly interact with mathematical concepts, making learning more engaging and easier to



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understand. The application is especially effective in helping students understand relationships between concepts, such as function graphs or geometric transformations (Fathurrahman & Fitrah, 2023; Suhaifi et al., 2021). GeoGebra is also commonly used in technology-based learning to enhance student engagement (Hasibuan & Yahfizam, 2024). One of its advantages is supporting students in understanding abstract concepts through simulations and experiments. By directly manipulating mathematical elements, students can experience how the concepts they are learning function in real-world contexts. GeoGebra provides students with the opportunity to learn independently and exploratively.

GeoGebra's availability on various platforms makes it easy for both students and teachers to access, both in and outside the classroom. With its design aligned with educational curricula, GeoGebra also becomes a flexible and relevant tool for use across different educational levels. Additionally, GeoGebra supports collaborative learning, allowing students to share and discuss mathematical solutions they encounter, enriching their learning experience (Sumianto et al., 2024). GeoGebra offers various benefits in mathematics education, such as enhancing student motivation by providing engaging and interactive experiences. Its powerful visualization features allow students to see and experience mathematical concepts directly. Additionally, GeoGebra facilitates independent exploration of concepts, enabling students to learn at their own pace. GeoGebra is also effective in helping students understand the relationships between concepts, such as the relationship between a function's graph and changes in the equation's parameters.

In this way, students can more easily grasp abstract concepts that were previously difficult to understand. This application also supports technology-based learning that aligns with modern advancements, making learning more dynamic and relevant to the needs of today's students. GeoGebra can be used for a wide range of mathematical topics, from geometry to calculus, making it highly flexible. Thus, GeoGebra is an invaluable tool for enhancing the quality of mathematics education (Al Ayyubi, Rohmatulloh, et al., 2024).

Realistic Mathematics Education (RME) is an innovative approach designed to make mathematics more relevant and meaningful for students. This approach aims to ensure that students not only learn mathematical concepts abstractly but also understand their real-life applications. In RME, students are encouraged to explore mathematical concepts through real-world contexts that



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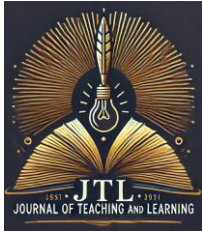
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are familiar to them, allowing them to see the connection between theory and practice. The learning process in RME emphasizes active student participation through group discussions, independent exploration, and collaboration. The teacher plays the role of a facilitator, guiding students to discover solutions rather than simply providing answers. This approach not only enhances the understanding of mathematical concepts but also trains students to think critically, creatively, and analytically in solving problems. Additionally, RME helps strengthen students' social skills, as they are encouraged to work together and discuss with their classmates. With its flexibility, RME can be applied at various educational levels and has been proven to enhance student motivation and achievement in mathematics in several countries (Nurjamaludin et al., 2021). The main principle of Realistic Mathematics Education (RME) is that mathematics is not seen merely as a collection of formulas and procedures to be memorized, but as an activity involving problem-solving and exploration. In RME, learning begins by providing contexts that are close to students' everyday experiences, allowing them to see the direct connection between mathematics and the world around them. These real-world contexts serve to make mathematical concepts more meaningful and easier to understand.

Additionally, RME encourages the use of various mathematical representations, such as images, models, or symbols, which allow students to visualize and grasp abstract concepts in a more concrete way. This enriches the way students think and interact with mathematics. RME emphasizes the role of students in constructing their own understanding through activities of exploration and inquiry. Learning in RME is progressive, starting with simple problems and gradually progressing to more complex ones, allowing students to build understanding step by step. Social interaction in the form of discussions and collaboration among students is also heavily emphasized to deepen their understanding of mathematical concepts. Through this approach, RME aims to create a more meaningful and applicable learning experience, where students not only memorize formulas but can also apply mathematics in their daily lives.

The integration of GeoGebra with the Realistic Mathematics Education (RME) approach allows students to explore and understand mathematical concepts through real-world contexts in a visual and interactive manner. GeoGebra acts as a tool that enriches students' learning experiences by providing opportunities to interact directly with mathematical objects and visualize the



relationships between concepts. This integration facilitates a deeper understanding of abstract mathematical ideas by grounding them in practical, real-life applications, making the learning process both engaging and meaningful. Students can manipulate and experiment with mathematical elements in GeoGebra, which enhances their ability to connect theoretical knowledge with real-world situations, supporting the core principles of RME (Pinayungan, 2023). Example of GeoGebra Application in Each Stage of the RME Learning Process: (1) Exploration of Real-World Problems; (2) Discussion and Collaboration; (3) Mathematical Formulation; and (4) Reflection and Proof.

In the first stage, students are introduced to a real-world problem relevant to daily life, such as calculating the area of a trapezoidal field. GeoGebra plays a crucial role in helping students visualize the trapezoid, allowing them to draw the field with varying side lengths and adjustable height. Students can then accurately measure dimensions of the trapezoid, such as the lengths of parallel sides and height, using the digital measurement tools available in GeoGebra. Through this process, students can directly observe how changes in the dimensions of the trapezoid affect its area. GeoGebra provides clear and dynamic visualizations that help students understand the relationship between the side lengths, height, and area. They can experiment with altering these parameters to see how the area formula for the trapezoid works under different conditions. This approach enables students to see the real-world application of mathematical concepts in their everyday lives, making the learning experience more relevant and meaningful. The use of GeoGebra also offers students the opportunity to engage actively in learning through direct exploration, rather than merely receiving information from the teacher (Siregar et al., 2023).

After students have completed the problem exploration using GeoGebra, they are then invited to discuss and collaborate in groups. This discussion focuses on the measurements and calculations that were done earlier. Students can share their results with one another and check if they arrived at similar answers or discovered differences in their calculations. GeoGebra facilitates this discussion by allowing students to digitally share their mathematical constructions. They can show the trapezoid they drew, demonstrate the measurements they performed, and compare their area calculation results. In the group, students can identify mistakes or find alternative methods to solve the problem. For example, if one student alters the length of the non-parallel sides, they can



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immediately see how this affects the calculation and discuss how to correct or modify the formula used. This collaboration encourages students to think critically and develop a deeper understanding, as they are not only solving the problem independently but also learning from their peers' perspectives. This discussion helps strengthen students' understanding of the concept being studied and enhances their social and communication skills (Birgin & Topuz, 2021).

In this stage, students are asked to generalize the patterns they discovered during the previous exploration and discussion. They then begin to formulate more abstract mathematical concepts, such as the formula for the area of a trapezoid. With the help of GeoGebra, students can visualize the relationship between the dimensions of the trapezoid and how this relationship can be generalized into a formula. GeoGebra allows students to manipulate the trapezoid and see how changes in the length of the sides or height affect the area, visually confirming that the formula applies to all trapezoids. Moreover, GeoGebra also enables students to test their formula under different conditions, such as changes in side lengths and height, so they can validate the accuracy of the formula. In this way, students are not just memorizing the formula, but also developing a deeper understanding of how the formula works and why it is true. GeoGebra provides students with the space to explore and test their understanding in a practical way, making the learning of mathematics more meaningful and applicable (Huda, 2024).

After students have formulated the formula for the area of a trapezoid, the next stage is reflection and proof. In this stage, students are given the opportunity to verify the formula they have discovered and compare it with manual calculations or other tools. GeoGebra provides the ability to verify the results in a highly visual and interactive way. Students can draw trapezoids with different dimensions, calculate the area using the formula they have developed, and compare the results with the automatic calculations performed by GeoGebra. In this way, students can assess whether the formula they created matches the practical calculation results and whether there are any differences that need to be corrected. This process encourages students to reflect on their understanding of the concept, identify any errors or inconsistencies, and reinforce their confidence in the correctness of the formula. GeoGebra helps facilitate this verification process, ensuring that the learning experience is both comprehensive and engaging (Hutajulu & Soesanto, 2023).



## CONCLUSION

Based on the explanation above, it can be concluded that the implementation of the GeoGebra application on students' mathematics learning, which uses the Realistic Mathematics Education (RME) model, does not show a significant correlation, and the correlation is very low. This suggests a basic assumption that the application of GeoGebra has not been optimally carried out by the students, regardless of their familiarity with the relatively new technology. Therefore, it may require earlier adjustments or improvements in the students' initial mathematical abilities, which might not yet be well-mastered, resulting in the lack of a significant correlation between the two. Thus, for future research, it is recommended to use other learning models to explore the effects of the GeoGebra application in mathematics learning, particularly in examining specific patterns within simple linear regression to assess the probability of the independent and dependent variables. However, before this, an assessment of the students' initial mathematical skills should be conducted so that the application of GeoGebra can be understood and implemented optimally.

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