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THE EFFECT OF GEOGEBRA-ASSISTED DISCOVERY LEARNING ON MATHEMATICAL CONCEPT UNDERSTANDING IN STATISTICS LEARNING

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ABSTRAK
This study aims to determine the effect of the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding ability in Statistics (Measures of Central Tendency) for Grade X students at SMA Negeri 1 Air Joman in the 2025/2026 Academic Year. This research employed a quantitative approach using a quasi-experimental method with a Pretest-Posttest Control Group Design. The population consisted of all Grade X students, comprising 6 classes with a total of 206 students. The samples were Class X-2 as the experimental class and Class X-4 as the control class. After the learning process was completed, the posttest results showed that the experimental class achieved higher scores than the control class. Therefore, it can be concluded that students' mathematical conceptual understanding taught through the Discovery Learning model assisted by the GeoGebra application is better than that of students taught through the direct instruction model.
Keywords: Discovery learning model; geogebra; students' mathematical conceptual understanding; statistics

ABSTRACT
Penelitian ini bertujuan untuk mengetahui pengaruh model discovery learning berbantuan geogebra terhadap kemampuan pemahaman konsep matematis siswa pada materi Statistika (Ukuran Pemusatan Data) Kelas X SMA Negeri 1 Air Joman Tahun Ajaran 2025/2026. Jenis penelitian ini adalah penelitian kuantitatif, menggunakan metode penelitian quasy experiment dengan desain penelitian adalah Pretest-Posttest Control Group Design. Populasi pada penelitian ini seluruh siswa kelas X yang berjumlah 6 kelas sebanyak 206 siswa. Sampel yang diambil kelas X-2 sebagai kelas eksperimen dan kelas X-4 sebagai kelas kontrol. Setelah proses pembelajaran selesai dilaksanakan, diperoleh hasil posttest kelas eksperimen lebih tinggi dibanding kelas kontrol. Dengan demikian diperoleh kesimpulan bahwa kemampuan pemahaman konsep matematis siswa menggunakan model Discovery Learning berbantuan Aplikasi Geogebra lebih baik dibandingkan menggunakan model pembelajaran langsung.
Kata Kunci: *Model discovery learning; geogebra; pemahaman konsep matematis siswa; statistika*

Introduction

Education is a conscious and systematic effort to create a learning environment that enables students to actively develop their inner and outer potentials (Habsy et al., 2024). These potentials include spiritual, moral, intellectual, and social skills that are beneficial not only for individuals themselves but also for society and the nation. Education is not merely about teaching; it also guides students to become independent and responsible individuals in social life.

One of the most important and beneficial subjects for individuals is mathematics (Mytra et al., 2023). Essentially, mathematics serves two fundamental functions in human life and the development of science. First, it functions as a powerful and effective tool for thinking. In this role, mathematics helps people process and organize ideas systematically through the use of symbols, notations, graphs, diagrams, and tables. In other words, mathematics provides a framework that enables individuals to interpret various situations objectively, systematically, and logically. Through mathematical thinking, people can make generalizations, draw deductive conclusions, and solve problems rationally and efficiently. Second, mathematics serves as a universal language in science. It acts as a medium of communication used to convey concepts, relationships, and scientific findings with a high degree of clarity and precision. One of the essential abilities that should be developed in students is mathematical conceptual understanding.

Mathematical conceptual understanding is one of the important aspects that students must possess in learning mathematics (Pratiwi et al., 2022). This ability is categorized as a hard skill that plays a significant role in helping students solve mathematical problems. Understanding refers to the ability to truly comprehend something. The level of understanding is higher than knowledge because before a person can understand a concept, they must first become familiar with it (Arumsari & Adirakasiwi, 2023). Therefore, understanding can be interpreted as a person's ability to know, explain, and correctly apply a concept. Conceptual understanding is crucial because mathematical ideas are interconnected and form the foundation for subsequent topics. If students have difficulty understanding basic concepts, it will hinder their understanding of more advanced material.

In line with this issue, on November 11, 2025, the researcher conducted an observation at SMA Negeri 1 Air Joman. The observation revealed that students' mathematical conceptual understanding was still relatively low, particularly in Statistics, specifically the topic of Measures of Central Tendency. This condition was caused by the fact that teachers still used monotonous teaching methods and learning models that did not adequately accommodate students' learning needs. In addition, teachers relied solely on mathematics textbooks during the learning process. After explaining the material, teachers immediately assigned practice questions without involving students in meaningful learning activities. As a result, students showed little participation during lessons. The low interest in learning mathematics among students also became an obstacle in the learning process, as many students still perceived mathematics as a difficult subject.

Furthermore, teachers at the school did not utilize interactive learning applications during classroom instruction. In fact, the use of educational applications can greatly support the learning process. The absence of such media caused students to depend entirely on information provided by the teacher. Consequently, students became less engaged in learning activities, and the classroom atmosphere appeared monotonous and boring. As a result, students had difficulty understanding mathematical concepts. This can be seen from students' responses to mathematical problems, which indicate that their conceptual understanding remains low.

One way to overcome students' low mathematical conceptual understanding is by selecting an appropriate learning model, such as the Discovery Learning model, which can encourage students to become actively involved and motivated in learning mathematics. Discovery Learning is a learning strategy that enables students to independently discover knowledge and concepts through structured learning experiences (Mukarom et al., 2024). The discovery learning model is a way to develop active student learning through the process of independent discovery, self-investigation so that the results obtained will last a long time in the memory, not easily forgotten by students (Pamungkas et al., 2020). Teachers provide guidance and learning resources, while students actively engage in investigation, observation, experimentation, and problem analysis.

Discovery Learning is also described as a learning model that encourages students to actively explore and process information so that they can construct their own mathematical understanding (Nadia et al., 2024). This model emphasizes student involvement in observing phenomena, formulating hypotheses, testing ideas, and drawing conclusions. Discovery Learning provides opportunities for students to think critically, solve problems creatively, and gain a deeper understanding of concepts through systematically designed learning activities.

The Discovery Learning model has a close relationship with students' mathematical conceptual understanding. At the stimulation stage, students are given problems related to statistical material to stimulate their curiosity. At the problem statement stage, students identify and formulate the problems to be solved. The data collection stage allows students to gather relevant information to discover the concepts being studied. Next, during the data processing stage, students organize and analyze the information to identify patterns and relationships. At the verification stage, students examine their findings to strengthen the concepts they have discovered. Finally, at the generalization stage, students draw general conclusions based on their findings. Through these stages, students do not merely receive information from the teacher but actively construct their own understanding of mathematical concepts, resulting in deeper and longer-lasting conceptual understanding.

Currently, the use of technological applications is increasingly important in various fields, including education. One innovation in learning is the use of educational applications such as GeoGebra, which can support students in solving problems and has great potential to improve students' mathematical conceptual understanding, particularly in Statistics (Measures of Central Tendency).

GeoGebra not only functions as a general mathematical visualization tool but can also be specifically utilized in statistics learning, especially in the topic of measures of central tendency. Through its Spreadsheet feature, students can input and process data directly, making the calculation of mean, median, and mode easier and more accurate. In addition, GeoGebra allows data to be presented in the form of tables, bar charts, and graphs, helping students observe data distribution patterns and understand the relationship between data and measures of central tendency.

In the Discovery Learning model, the use of GeoGebra supports students in independently discovering concepts through data exploration activities (Sari et al., 2025; Krisnanti et al., 2020). Geogebra discovery learning methodology influences student performance . Students can manipulate data values in the Spreadsheet feature and directly observe changes in the mean, median, and mode. Such activities encourage students to identify the characteristics of each measure of central tendency, compare the results obtained, and draw conclusions based on their own observations. Therefore, GeoGebra serves as a tool that facilitates concept discovery and helps improve students' understanding of statistical concepts. The Discovery Learning learning approach can improve student learning outcomes (Lidia et al., 2026).

Numerous studies on the Discovery Learning model have shown positive results in improving students' mathematical abilities. Hermawan, Anggiana, and Rahman (2023) found that the use of Discovery Learning assisted by GeoGebra significantly improved senior high school students' conceptual understanding. Furthermore, Nadia et al. (2024) reported that Discovery Learning provides students with opportunities to construct their own knowledge through concept discovery, thereby enhancing their mathematical conceptual understanding. The right learning model contributes to students' interest in learning mathematics (Vahlia et al., 207).

The use of GeoGebra in mathematics learning has also been proven to have a positive impact on student achievement. Safriati (2021) stated that GeoGebra helps students visualize abstract mathematical concepts, making them easier to understand. Similarly, Sembiring (2020) explained that GeoGebra can increase student engagement in mathematics learning through its interactive and attractive visual features.

Based on these previous studies, it can be concluded that both Discovery Learning and GeoGebra have the potential to improve students' mathematical conceptual understanding. However, most previous studies have focused on algebra, geometry, and linear equations. Research examining the effect of Discovery Learning assisted by GeoGebra on students' mathematical conceptual understanding in statistics, particularly measures of central tendency at the senior high school level, remains limited. Therefore, this study aims to fill this research gap by investigating the effect of the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding in Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year.

Research Methods

This study employed a quantitative approach using a quasi-experimental research method. Experimental research is a method used to understand how a particular learning model influences other variables within a controlled environment. Therefore, this study investigated the effect of the Discovery Learning model assisted by the GeoGebra application on students' mathematical conceptual understanding in Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year. In this study, the experimental class received mathematics instruction using the Discovery Learning model assisted by the GeoGebra application, while the control class was taught using the direct instruction model.

The study was conducted at SMA Negeri 1 Air Joman, located on Lubuk Palas Road, Air Joman District, Asahan Regency, North Sumatra Province. The research was carried out during the second semester of the 2025/2026 academic year.

The population of this study consisted of all Grade X students of SMA Negeri 1 Air Joman, totaling 206 students distributed across six classes in the 2025/2026 academic year. The sample consisted of Class X-2 as the experimental class and Class X-4 as the control class, with each class comprising 36 students, resulting in a total sample of 72 students. The sampling technique used was purposive sampling, which involves selecting samples based on specific considerations relevant to the research objectives. The selection of Classes X-2 and X-4 was based on several criteria: (1) both classes were at the same grade level and received the same instructional material according to the applicable curriculum; (2) both classes were taught by the same mathematics teacher, ensuring that differences in learning outcomes were not influenced by differences in teaching styles; (3) the number of students in each class was relatively balanced, facilitating comparison of research results; and (4) based on information from the mathematics teacher and school academic records, the average academic abilities of students in both classes were relatively equivalent. These considerations were intended to minimize differences in class characteristics that could affect the research outcomes, thereby allowing the effect of the treatment to be observed more objectively.

Furthermore, purposive sampling was employed because the researcher was unable to conduct full random assignment, as the classes had already been formed by the school administration. Therefore, purposive sampling was considered the most appropriate technique for obtaining samples with relatively homogeneous characteristics and relevance to the research objectives.

The research design used in this study was the Pretest–Posttest Control Group Design, as it allowed the researcher to compare changes in students' mathematical conceptual understanding before and after the treatment in both the experimental and control groups. Through the administration of a pretest, the researcher was able to determine the initial conditions of both groups, enabling differences in posttest results to be interpreted as the effect of the treatment. Additionally, the use of a control group helped reduce the influence of extraneous variables, such as students' prior abilities, previous learning experiences, and environmental factors that could affect the research outcomes. Therefore, this design was considered effective for measuring the effect of implementing the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding.

In this design, both the experimental and control classes were administered a pretest and a posttest. However, only the experimental class received instruction using the Discovery Learning model assisted by the GeoGebra application.

Instruction in the experimental class was conducted using the Discovery Learning model assisted by GeoGebra over four meetings on statistical topics, specifically measures of central tendency (mean, median, and mode). Each meeting lasted for 2 × 40 minutes.

The stages of the Discovery Learning model implemented in this study were as follows:

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a. Stimulation
The teacher presented contextual problems related to statistical data to stimulate students' curiosity.
b. Problem Statement
Students identified the given problems and formulated questions regarding how to determine the mean, median, and mode of a dataset.
c. Data Collection
Students gathered information through worksheets and explored data using GeoGebra. At this stage, students entered data into the GeoGebra Spreadsheet feature to observe data characteristics.

d. Data Processing
Students processed the collected data using GeoGebra to determine the mean, median, and mode and observed changes that occurred when the data were modified.
e. Verification
Students compared the results obtained from GeoGebra with manual calculations to verify the correctness of the concepts they had discovered.
f. Generalization
Students drew conclusions regarding measures of central tendency based on the results of their exploration and discussion activities.

During the learning process, GeoGebra was utilized as a tool for data visualization and exploration through its Spreadsheet feature and the presentation of data in the form of tables and graphs. Student activities included entering data, observing the results of calculations related to measures of central tendency, participating in group discussions, completing student worksheets (LKPD), and presenting their findings in front of the class. The research design is presented as follows in Table 1:

Table 1. Research Design.

Class	***Pre-Test***	**Treatment**	***Post-Test***
Eksperiment	T_1	X_1	T_2
Control	T_1	X_2	T_2

Keterangan:

X_1 : Perlakuan pada kelas eksperimen yaitu model *Discovery learning* berbantuan aplikasi *Geogebra*
X_2 : Perlakuan pada kelas kontrol yaitu model pembelajaran konvensiona
T_1 : Tes awal (*Pretest*) pada kelas eksperimen
T_1 : Tes awal (*Pretest*) pada kelas kontrol
T_2 : Tes akhir (*Prosttest*) pada kelas eksperimen
T_2 : Tes akhir (*Prosttest*) pada kelas kontrol

A research instrument is a tool used to measure observed phenomena, whether natural or social. In this study, the instrument consisted of 10 essay questions for the pretest and 10 essay questions for the posttest. These tests were designed to assess the context and competencies related to students' mathematical conceptual understanding based on the indicators of mathematical conceptual

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understanding. To ensure the quality of the test instrument, several analyses were conducted, including the validity test**,** reliability test**,** discrimination index analysis, and difficulty level analysis.

A validity test is used to determine whether an instrument accurately performs its measurement function and possesses a high degree of precision. Precision in a validity test refers to the instrument's ability to detect even small differences in the attribute being measured (Sanaky, 2021). To determine the validity of each test item, the Pearson Product-Moment Correlation Formula was used as follows:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{(N(\sum X^2) - (\sum X)^2)\}\{(N(\sum Y^2) - (\sum Y)^2)\}}}$$

Source: (Ramadhan et al., 2024)
information:
r_{xy} = Correlation coefficient between item score and total score
N = Number of respondents
$\sum XY$ = Sum of the products of X and Y
$\sum X$ = Sum of item scores
$\sum Y$ = Sum of total scores
$\sum X^2$ = Sum of squared item scores
$\sum Y^2$ = Sum of squared total scores

The validity coefficient obtained is then compared with the critical value of the correlation coefficient r_{table} at a significance level of 0.05. A test item is considered valid if $r_{\text{calculated}} > r_{\text{table}}$, and invalid if $r_{\text{calculated}} \leq r_{\text{table}}$. Pretest Validity Test Results in Table 2.

Table 2. Pretest Validity Test Results

Number question	r calculated	r table (0,361)	Information
1	0,685	0,361	Valid
2	0,592	0,361	Valid
3	0,748	0,361	Valid
4	0,471	0,361	Valid
5	0,624	0,361	Valid
6	0,315	0,361	Invalid
7	0,287	0,361	Invalid
8	0,201	0,361	Invalid
9	0,174	0,361	Invalid
10	0,332	0,361	Invalid

Posttest Validity Test Results in Table 3.

Table 3. Posttest Validity Test Results

Number question	r calculated	r table (0,361)	Information
1	0,721	0,361	Valid
2	0,647	0,361	Valid
3	0,783	0,361	Valid

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4	0,518	0,361	Valid
5	0,694	0,361	Valid
6	0,298	0,361	Invalid
7	0,243	0,361	Invalid
8	0,319	0,361	Invalid
9	0,188	0,361	Invalid
10	0,275	0,361	Invalid

Furthermore, a reliability test was conducted to determine the extent to which the measurement results obtained from the instrument could be considered consistent and dependable. Reliability indicates the degree of consistency of an instrument when used repeatedly under similar conditions. In this study, Cronbach's Alpha was used to calculate the test instrument's reliability coefficient. The formula is as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum s_i^2}{s_t^2}\right)$$

Source: (Ramadhan et al., 2024)
information:
r_{11} = Reliability coefficient of the instrument
n = number of test items
$\sum s_i^2$ = Sum of item variances
s_t^2 = Total variance of the test scores

Reliability testing was conducted by comparing the value of $r_{11} > r_{tabel}$, the test items are considered reliable in Table 4.

Table 4. Reliability Test Criteria

Coefficient range	**Criteria**
0,80 – 1,00	Very high
0,60 – 0,79	High
0,40 – 0,59	moderate
0,20 – 0,39	Low
0,00 – 0,19	Ver low

Based on the reliability test results, the pretest instrument obtained a Cronbach's Alpha coefficient of 0.812, while the posttest instrument obtained a Cronbach's Alpha coefficient of 0.845. Both coefficients fall into the very high reliability category, indicating that the research instruments possess a high level of internal consistency and are suitable for measuring students' mathematical conceptual understanding.

Furthermore, a discrimination index test was conducted to determine the ability of each test item to distinguish between high-achieving students and low-achieving students. According to (Tanjungpura and Klasik 2024), the discrimination index of a test item can be calculated using the following formula:

$$DP = \frac{\bar{X}_A - \bar{X}_B}{SMI}$$

Source: (Mustaqin & Sulisti, 2024)
information:
DP = Discrimination Index
$\bar{X}_A$ = Mean score of the upper group

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$\bar{X}_B$ = Mean score of the lower group
SMI = Maximum Ideal Score

The discrimination index was evaluated by comparing the obtained value with the established criteria. If $0{,}20 \leq DP \leq 0{,}40$, the test item is categorized as Fairly Good.

The difficulty level test was conducted to determine the difficulty index of each test item. The formula used in this study was as follows:

$$P = \frac{B}{JS}$$

source: (Dianova & Anwar, 2024)
information:
P = Difficulty Index of the test item
B = Number of correct answers
JS = Total number of answer sheets (students)

The difficulty index was interpreted according to the established criteria. If: $0{,}30 < IK \leq 0{,}70$, the test item is classified as Moderate in difficulty.

The data collection technique in this study was carried out through students' responses related to their mathematical conceptual understanding. Data on students' mathematical conceptual understanding before the implementation of the Discovery Learning model assisted by GeoGebra were collected through a written pretest, while data on students' mathematical conceptual understanding after the implementation of the Discovery Learning model assisted by GeoGebra were collected through a written posttest.

The data analysis technique used in this study included a normality test, which aims to improve the accuracy of hypothesis testing. Since hypothesis testing can only be conducted when the data being analyzed are normally distributed, a normality test is essential.

The Liliefors Test was used to examine the normality of the data in this study. The hypotheses formulated for the normality test were as follows:
H_0:The mathematical conceptual understanding test data are normally distributed.
H_1:The mathematical conceptual understanding test data are notnormally distribut ed.

The decision-making process is based on the critical value of the Liliefors test at a significance level of $a = 0{,}05$. If $L_{hitung} < L_{tabel}$, then H_0 is accepted, indicating that the data are normally distributed. If $L_{hitung} > L_{tabel}$, then H_1 is rejected, indicating that the data are not normally distributed.

After conducting the normality test, a homogeneity test was performed. The homogeneity test used the F-statistic test**,** which is calculated using the following formula:

$$F = \frac{largest\ variance}{smallest\ variance}$$

The hypotheses for the homogeneity test are formulated as follows:
H_0: The variances of the two groups are equal (homogeneous)
H_1: The variances of the two groups are not equal (heterogeneous)

The testing criteria at a significance level of $a = 0{,}05$ are as follows:

1. if $F_{calculated} > F_{table}$, then H_0 is rejected.
2. if $F_{calculated} < F_{table}$, then H_1 is accepted.

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Subsequently, the research hypothesis was tested using a right-tailed independent samples t-test to compare the mean scores of the two groups. The hypotheses tested were as follows:

$H_0: \mu_1 = \mu_2$ There is no significant effect of the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding in Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year.

$H_1: \mu_1 \neq \mu_2$ There is a significant effect of the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding in Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year.

The research hypothesis is formulated as H_1, while the statistical hypothesis is formulated as H_0. The calculation of the t-test is carried out using the following formula:

$$t_{hitung} = \frac{\overline{x_1} - \overline{x_2}}{s\sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$S = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

Source: (Mustaqin & Sulisti, 2024)

information:

$\overline{x_1}$ = Mean score of the experimental class
$\overline{x_2}$ = Mean score of the control class
n_1 = Number of students in the experimental class
n_2 = Number of students in the experimental class
s_1^2 = Variance of the experimental class
s_2^2 = Variance of the control class

The decision criteria for the hypothesis test are as follows:

1. if $t_{calculated} < t_{table}$, then H_0 rejected.
2. if $t_{calculated} > t_{table}$, then H_1 is accepted.

Results and Discussion

This study aimed to determine the effect of the Discovery Learning model assisted by GeoGebra on students' mathematical conceptual understanding in Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year. The study was conducted at SMA Negeri 1 Air Joman. The sample consisted of two classes: the experimental class (X-2) and the control class (X-4), with 36 students in each class. The experimental class was taught using the Discovery Learning model assisted by the GeoGebra application, while the control class received direct instruction. After all learning materials had been delivered to both classes, the same test was administered to determine differences in students' abilities between the two groups.

The results of the study showed that students' mathematical conceptual understanding taught through the Discovery Learning model assisted by GeoGebra was better than that of students taught through direct instruction. Based on the posttest results,

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the experimental class obtained a mean score of 84.72 with a standard deviation of 11.272, while the control class achieved a mean score of 55.13 with a standard deviation of 14.952. This difference in mean scores indicates that the mathematical conceptual understanding of students in the experimental class was superior to that of students in the control class after receiving instruction through the Discovery Learning model assisted by GeoGebra.

The improvement in mathematical conceptual understanding in the experimental class was not only reflected in the higher average scores but could also be explained by the learning process implemented during the study. In the experimental class, students were actively involved in every stage of the Discovery Learning process, including stimulation, problem identification, data collection, data processing, verification, and conclusion drawing. Through these stages, students were provided with opportunities to discover and construct their own understanding of measures of central tendency, making the learning experience more meaningful and enhancing conceptual understanding.

Furthermore, the use of the GeoGebra application helped students visualize statistical data more clearly. Students were able to observe the processes of determining the mean, median, and mode directly, making abstract concepts easier to understand. The visual representations provided by GeoGebra also enabled students to connect mathematical concepts with data representations, thereby reducing misconceptions and errors in solving statistical problems.

In contrast, the learning process in the control class was dominated by teacher explanations and practice exercises. This condition resulted in students receiving information directly without actively engaging in the process of concept discovery. Consequently, students' understanding of measures of central tendency tended to be less comprehensive compared to that of students in the experimental class.

Therefore, the differences in learning outcomes between the experimental and control classes not only indicate differences in average achievement but also suggest that the Discovery Learning model assisted by GeoGebra provides a more effective learning experience for developing students' mathematical conceptual understanding in statistics.

The findings of this study are consistent with those of Hermawan et al. (2023), who reported that Discovery Learning assisted by GeoGebra can improve students' mathematical conceptual understanding. This study also supports the findings of Safriati (2021), which demonstrated that GeoGebra helps students understand mathematical concepts more deeply through interactive visualizations.

The results of this study indicate that the integration of the Discovery Learning model and the GeoGebra application can serve as an effective alternative instructional approach for improving students' mathematical conceptual understanding, particularly in the topic of measures of central tendency in statistics. Therefore, mathematics teachers may consider implementing the Discovery Learning model assisted by GeoGebra as an instructional innovation to enhance both the quality of the learning process and students' learning outcomes in Table 5.

Table 5. Results of the Normality Test Calculation for Pretest and Posttest Data

Question	**Class**	$\bar{X}$	s	$L_{\text{calculated}}$	L_{table}	**Criteria**
Pretest	Eksperiment	38,19	18,211	0,093	0,147	$L_{\text{calculated}} < L_{\text{table}}$
	Control	20,41	13,752	0,051	0,147	$L_{\text{calculated}} < L_{\text{table}}$

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Posttest	Eksperiment	84,72	11,272	0,107	0,147	$L_{\text{calculated}} < L_{\text{table}}$
	Control	55,13	14,952	0,050	0,147	$L_{\text{calculated}} < L_{\text{table}}$

From the table above, it can be seen that $L_{\text{calculated}} < L_{\text{table}}$. Therefore, it can be concluded that the pretest and posttest data are normally distributed.

In addition to the implementation of the Discovery Learning model assisted by GeoGebra, several other factors may have contributed to the research findings. One of these factors is students' learning motivation. Students with high learning motivation tend to participate more actively in each stage of the learning process, making it easier for them to understand the concepts being studied. Prior mathematical ability may also influence learning outcomes, as students who already possess a strong foundational understanding can more easily connect new concepts with their existing knowledge. Furthermore, students' technological skills play an important role in the effectiveness of GeoGebra implementation. Students who are familiar with digital devices and educational applications generally find it easier to utilize GeoGebra's features to explore statistical concepts. Another important factor is the classroom learning environment, including the learning atmosphere, teacher–student interaction, and student participation during the instructional process. Although this study demonstrates that Discovery Learning assisted by GeoGebra has a positive effect on students' mathematical conceptual understanding, these factors may also have contributed to the results obtained. Therefore, future research is recommended to examine the influence of these factors in greater depth in order to obtain a more comprehensive understanding of the effectiveness of Discovery Learning assisted by GeoGebra in mathematics education.

The homogeneity test was conducted using the F-test. The results of the homogeneity test for both the experimental class and the control class can be seen in the following Table 6.

Table 6. Results of the Homogeneity Test Calculation for Pretest and Posttest Data

Question	**Class**	s^2	$f_{\text{calculated}}$	f_{table}	**Criteria**
Pretest	Eksperiment	331,647	1,754	1,757	$f_{\text{calculated}} < f_{table}$
	Control	189,107			
Posttest	Eksperiment	127,063	1,799	1,757	$f_{\text{calculated}} < f_{table}$
	Control	228,571			

From the table above, it can be seen that $f_{hitung} < f_{\text{table}}$. Therefore, H_0 is accepted, which indicates that there is no significant difference in variance between the experimental class and the control class, or in other words, the data are homogeneous.

Based on the results of the homogeneity test, the calculated F-value was found to be smaller than the critical F-value, resulting in the acceptance of H0H_0H0. This finding indicates that the variances of the data in both the experimental and control classes are homogeneous, meaning that they have relatively similar levels of variability. In other words, the differences in the results obtained between the two groups are not caused by significant differences in variance but are more likely attributable to the learning treatment applied.

The fulfillment of the homogeneity assumption is one of the essential requirements for the use of parametric statistical tests, particularly the t-test employed in this study. Homogeneity of variance indicates that both groups originate from populations with

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relatively similar distributions of data, allowing comparisons of the mean scores between the experimental and control classes to be conducted more objectively and accurately.

The results of the homogeneity test, which demonstrated that the data were homogeneous, also support the appropriateness of using a parametric hypothesis test. Since both the normality and homogeneity assumptions were satisfied, the results of the hypothesis testing using the t-test can be considered reliable in determining whether the Discovery Learning model assisted by GeoGebra has an effect on students' mathematical conceptual understanding. Therefore, any differences found between the two classes can be interpreted as the effect of the instructional treatment implemented during the learning process.

The hypothesis test was conducted using an independent samples t-test based on a comparison of means with a right-tailed test. Accordingly, the statistical hypotheses were formulated as follows in Table 7.

Table 7. Results of the Hypothesis Test Calculation for Pretest and Posttest Data

class	$\bar{X}$	N	$t_{\text{calculated}}$	t_{table}
Eksperiment	84,72	36	34,74	1,667
Control	55,13	36		

Conclusion and Suggestion

Based on the results of the study, the Discovery Learning model assisted by GeoGebra had a significant effect on students' mathematical conceptual understanding of Statistics (Measures of Central Tendency) among Grade X students of SMA Negeri 1 Air Joman in the 2025/2026 Academic Year. Students who participated in learning through the Discovery Learning model assisted by GeoGebra demonstrated better mathematical conceptual understanding than those who participated in direct instruction.

These findings indicate that the integration of Discovery Learning and GeoGebra helps students construct mathematical concepts independently through discovery-based activities and data visualization. This study contributes to strengthening the use of technology-based learning models to improve the quality of mathematics instruction. Practically, the implementation of Discovery Learning assisted by GeoGebra can serve as an alternative teaching approach for mathematics teachers in teaching statistics, making learning more interactive, meaningful, and student-centered.

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