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THE EFFECT OF USING THE GEOGEBRA APPLICATION-ASSISTED DISCOVERY LEARNING MODEL ON LEARNING OUTCOMES

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ABSTRACT
The purpose of this study is to evaluate the effectiveness of the Geogebra app in facilitating the discovery learning paradigm in mathematics instruction for junior high school pupils. The experimental technique is used for the investigation. Using Simple Random Sampling, 17 students from the eighth grade boys' class and 20 students from the eighth grade girls' class served as the experimental and control groups, respectively. The assessment tool used is an essay-based exam. Observation, interviews, documentation, and testing are all methods of data gathering, and a t-test is used for data analysis. The study found that compared to traditional learning models, the discovery learning model with the use of the Geogebra app had an effect size of 2.143>2.030, indicating a relationship between the two. This is due to the fact that students are motivated to actively participate in problem-solving via the exploration of their own talents, investigation of the issue, and eventual solution, all of which are supported by the discovery learning paradigm and made possible by the Geogebra program. It follows that Geogebra's discovery learning methodology affects Sunan Ampel Punggur Middle School students' performance in the classroom.
Keywords: discovery learning, geogebra, learning outcomes, statistics

ABSTRAK
Tujuan dari penelitian ini adalah untuk mengevaluasi efektivitas aplikasi Geogebra dalam memfasilitasi paradigma pembelajaran penemuan dalam pengajaran matematika untuk siswa sekolah menengah pertama. Teknik eksperimen digunakan untuk investigasi. Dengan menggunakan Simple Random Sampling, 17 siswa dari kelas delapan putra dan 20 siswa dari kelas delapan putri masing-masing berperan sebagai kelompok eksperimen dan kontrol. Alat penilaian yang digunakan adalah ujian berbasis esai. Observasi, wawancara, dokumentasi, dan pengujian merupakan metode pengumpulan data, dan uji-t digunakan untuk analisis data. Penelitian ini menemukan bahwa dibandingkan dengan model pembelajaran tradisional, model pembelajaran penemuan dengan penggunaan aplikasi Geogebra memiliki ukuran efek 2,143>2,030, yang menunjukkan hubungan antara keduanya. Hal ini disebabkan oleh fakta bahwa siswa termotivasi untuk berpartisipasi aktif dalam pemecahan masalah melalui eksplorasi bakat mereka sendiri, penyelidikan masalah, dan solusi akhirnya, yang semuanya didukung oleh paradigma pembelajaran pembelajaran penemuan dan dimungkinkan oleh program Geogebra. Hal ini dapat disimpulkan bahwa metodologi pembelajaran penemuan Geogebra mempengaruhi prestasi siswa SMP Sunan Ampel Punggur di kelas.
Kata kunci: *discovery learning, geogebra, hasil belajar, statistika*

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Introduction

Science and technology develop over time, which allows the development of new technologies. (Mulyani & Haliza, 2021) . Active learning is a goal of education, aiming to help students reach their full potential. Abstract concepts are crucial in mathematics (Anwar & Rahmawati, 2017). Students' abilities in reasoning, analysis, and systematization can be significantly improved through the study of mathematics. (Saputri et al., 2020). Indonesian students' math skills have declined since the 2018 PISA and are now among the lowest, consistent with 2003 findings, according to the 2022 Programme for International Student Assessment (PISA). Out of 81 countries, Indonesian students ranked 69th in 2022 with an average math score of 369.3. This placed them in the 15th lowest group, while Singapore achieved the best score with 559.7. In 2018, Indonesian students scored an average of 379.

This justification supports the ongoing efforts of the Indonesian Ministry of Education, Culture, Research, and Technology to improve classroom teaching standards. As stated in Ministerial Regulation Number 21 of 2022 concerning Educational Assessment Standards for Early Childhood Education, Elementary Education, and Secondary Education, assessment is defined as the process of collecting and analyzing data to ensure the achievement of learning objectives and outcomes for students. The end result of any educational endeavor is known as learning outcomes. (Istidah et al., 2022). To determine the extent of instructor success in carrying out learning activities, it is necessary to assess the learning process (Widiyanto & Istiqomah, 2020) Learning outcomes have several types, namely cognitive, affective, and psychomotor aspects (Audie, 2019).

Researchers conducted a survey on how teachers implement the learning process in the classroom as the first step in this study. Based on observations gathered during mathematics classes at Sunan Ampel Punggur Middle School, tactics including practice problems and a lecture style were used to help students learn. When the instructor takes center stage in class, students tend to be less actively involved in their own education. Unfortunately, this means that many students still do not receive the best educational opportunities. (Pagesti et al., 2021) .

Based on the results of interviews I conducted at Sunan Ampel Punggur Junior High School with the eighth-grade mathematics teacher, I discovered several problems. The problem I encountered was that some students lacked knowledge and skills in the learning material, even though the material taught should have been understood since elementary school. Therefore, at the beginning of this lesson, they had to repeat or even relearn basic material that students should have already understood. The results of the final semester exams showed that efforts to implement an appropriate learning model were unsuccessful. Of the 37 eighth-grade students, only seven (18.9%) completed the mathematics course, while thirty (81.1%) had not.

From these figures, it can be concluded that student learning outcomes are still relatively low, as completion rates are much lower than dropout rates. There is no separation between learning model approaches that align with learning content and the achievement of learning objectives. Teacher involvement is crucial to addressing this obstacle and achieving student learning outcomes. Selecting a

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learning model that aligns with the material being taught significantly impacts how well students learn. Student mathematics performance is expected to be improved by using a discovery learning approach, among other things. "Discovery learning" is a situation in which students are required to demonstrate organizational skills without receiving explicit guidance (Sulfemi, 2019) This learning model was initiated by Jerome Bruner in the 1960s, emphasizing that learning occurs through doing (Anjaeni, 2021). Discovery learning is a process in which students discover concepts themselves using their experiences (Vahlia, 2023). The use of discovery learning enables the transformation of traditional, teacher-centered, or knowledge-centered learning models into more collaborative, student-centered learning models. Furthermore, the use of the GeoGebra application helps accelerate understanding because students can directly see the results obtained, which greatly supports the discovery process, thus improving learning outcomes more optimally. The GeoGebra application is a dynamic mathematics learning software (Yusrina et al., 2020) . GeoGebra is software that can assist the learning process as a tool to solve problems (Faradisa, 2019) .

The researchers in this study chose to combine the discovery learning model with the GeoGebra application learning media in the hope that this would pique students' interest in mathematics lessons and lead to greater openness to learning from the lessons. Students should be able to obtain more accurate answers with the help of the GeoGebra application, which should reduce the likelihood that they will answer questions incorrectly. This is further supported by the claim that students whose lessons included GeoGebra had an easier time understanding and using linear equation graphs than those whose lessons did not include it, all because GeoGebra made learning a fun and efficient process. (Farihah, 2015) .

This is reinforced by research that examines the impact of using discovery learning models in mathematics classes and found that the model improves student achievement compared to traditional learning methods. This study, entitled "Implementation of Mathematics Learning with Discovery Learning Models on Mathematics Learning Outcomes Reviewed from the Creativity of Grade VII Students of SMP Negeri 2 Baki Sukoharjo" and compares the two approaches. Therefore, this project aims to achieve the same positive impact by applying the discovery learning paradigm to mathematics topics at SMP Sunan Ampel Punggur. Unfortunately, GeoGebra and other technology-based learning resources have not been used in this study (Rivai, 2017) .

However, additional research has shown that student learning outcomes are superior when they use the GeoGebra-assisted discovery learning paradigm compared to when they do not. What makes this study unique is the instructional materials and electronic media used. While previous studies used laptops or desktop computers to analyze linear equations, this study relied on smartphones for statistical analysis. The fact that junior high school students have easier access to mobile phones highlights this difference. (Putri, 2023) . Based on the description above, the aim is to test the hypothesis that junior high school students' mathematics learning outcomes will improve if they use the discovery learning model with the help of the Geogebra application.

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Research methods

This study uses a quantitative research method using an experimental design. The research design used is *a Nonequivalent Control Group Design* which is part of the *Quasy Experimental Design approach* (Sugiyono, 2022). This study uses Simple Random Sampling as its sampling strategy. A total of 17 male students of class VIII became the experimental group and 20 male students of class VIII became the control group. The type of exam used was an essay exam with three questions. Data collection methods used were tests, interviews, documentation, and observation. Before administering the test, content validity and reliability tests were conducted using the *Cronbach's Alpha formula. The prerequisite tests for data analysis were the Liliefors* normality test and the *Bartlett homogeneity test.* In addition, a t-test was used to test the hypothesis of the effect of the Geogebra program on junior high school students' mathematics learning outcomes with a *discovery learning approach.*

Results and Discussion

Validity is a measuring tool for measuring data (Amanda et al., 2019) . Validator in this study, namely, Yeni Rahmawati ES, M.Pd. as validator 1, Ira Vahlia, M.Pd. as validator 2, and Latifatul Munawaroh, S.Pd. as validator 3. In Table 1, you can see the results of the instrument validation analysis shown in Table 1.

Table 1. Results of RPP validation

Lesson Plan Validation Results				
Aspect	**Presentation**			**Average Percentage Per Aspect**
	V1	**V2**	**V3**	
Lesson Plan Format	80%	80%	93%	84%
Contents	80%	87%	90%	86%
Language	80%	60%	80%	73%
Average	80%	76%	88%	81%
Information				**Very Valid**

In accordance with Table 1, three components were identified, namely: first, the RPP format component obtained an average score of 84% and was considered very valid; second, the RPP content component obtained an average score of 86% and was considered very valid; and third, the language component obtained an average score of 73% and was considered valid as shown in Table 2.

Table 2. Results of LKPD validation

LKPD Validation Results				
Aspect	**Presentation**			**Average Percentage Per Aspect**
	V1	**V2**	**V3**	
Format	73%	93%	93%	86%
Contents	80%	80%	89%	83%
Language	80%	60%	80%	73%
Average	78%	78%	87%	81%
Information				**Very Valid**

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The LKPD format aspect that falls into the very valid category obtained an average result of 86%, based on Table 2. The LKPD content aspect that falls into the valid category obtained an average result of 83%. Meanwhile, the language aspect obtained an average result of 73%, based on Table 3.

Table 3. Results of the validation of the questions

Test Question Validation Results				
Aspect	**Presentation**			**Average Percentage Per Aspect**
	V1	**V2**	**V3**	
Lesson Plan Format	92%	84%	100%	92%
Contents	87%	80%	87%	85%
Language	93%	80%	80%	84%
Average	91%	81%	89%	87%
Information				**Very Valid**

Table 3 shows that of the three components, the construct component has an average assessment result of 92% which is very valid from the three validators, the content component has an average result of 85% and is also very valid, and the language component has an average result of 84% and is also very valid.

testing is a measurement process to determine the level of data consistency (Hakim et al., 2021) . The reliability of the research test questions was tested using the *Cronbach's Alpha reliability test.* Furthermore, according to Arikunto (2016), the following criteria or indexes were used to analyze the results:

Table 4. Interpretation Criteria for Correlation Coefficients

Coefficient Interval	**Relationship Level**
$0.00 \leq r_{11} < 0.20$	Very Low
$0.20 \leq r_{11} < 0.40$	Low
$0.40 \leq r_{11} < 0.60$	Currently
$0.60 \leq r_{11} < 0.80$	Tall
$0.80 \leq r_{11} < 1.00$	Very high

The participants in this study were sixteen male students from the ninth grade. Since the item score variance was calculated to obtain a value r_{11} of 0.6719, the reliability test for the test items fell into the high category, making it suitable for use. The t-test was used to assess the data analysis in this study.

The purpose of this experiment was to compare the results of using a traditional learning paradigm with a paradigm incorporating the GeoGebra program for learning new things. Prior to conducting the hypothesis test, a preparatory analytical test was conducted to ensure that the data obtained from the students' posttests were normal and homogeneous.

Normality Test

The normality test in this study used the Liliefors test. The normality test data for the experimental and control classes are presented in Table 5.

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Table 5. *Post-test* normality test

Group	Average	L_{hitung}	L_{tabel}	Test Decision
Experiment	65.47	0.142	0.206	H_0accepted
Control	55.45	0.109	0.190	H_0accepted

Based on Table 5, the calculation of the normality test based on the post-test score data of the experimental class students, which was carried out using statistical calculations at a significance level of α = 0.05, shows that $L_{hitung} < L_{tabel}$which is 0.142 < 0.206, which indicates that L is outside the critical region. This indicates that the experimental class is regularly distributed because H_0it is accepted. Conversely, $L_{hitung} < L_{tabel}$ namely 0.109 < 0.190, in the control class, which was carried out with a statistical significance threshold of α = 0.05, which indicates that L is outside the crucial region. This indicates that the control class is regularly distributed because H_0it is accepted.

Homogeneity Test

The purpose of the homogeneity test in this study was to compare the variances of the two groups. The Bartlett test was used to assess homogeneity in this study. The results of the homogeneity test for student learning outcomes are shown in Table 6.

Table 6. *Post-test* homogeneity test

Group	Average	Variance	χ^2_{hit}	χ^2_{tab}	Test Decision
Experiment	65.47	225.38	0.212	3,841	H_0accepted
Control	55.45	180.15			

Based on Table 6, the homogeneity test using the post-test scores of students in both the experimental and control classes with a significance level of α = 0.05 shows that $\chi^2_{hit} < \chi^2_{tab}$ 0.212 < 3.841, which leads to acceptance $H_0$and the conclusion that both populations show similar variances.

Hypothesis Testing

The t-test was applied to test the hypotheses after the preparatory test was completed. The post-test results of students from the experimental and control groups were used to evaluate the hypotheses. Table 7 shows the results of the t-test used to test class balance.

Table 7. t-test

Group	Average	t_{hitung}	t_{tabel}	Test Decision
Experiment	65.47	2,143	2,030	H_0rejected
Control	55.45			

Based on the research results, with a significance threshold of α = 0.05, $t_{hitung} = 2{,}143$ and$t_{tabel} = 2{,}030$. By rejecting H_0, we obtain that $t_{hitung} > t_{tabel}$ which shows that the traditional learning model and the discovery learning model

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assisted by the Geogebra program provide different results in terms of student learning.

This strengthens the hypothesis that GeoGebra software, combined with the discovery learning model, influences junior high school students' mathematics achievement. During the learning process, the experimental and control classes were given different treatments, which influenced learning outcomes. While the control group used a traditional learning model, the experimental group received therapy using the GeoGebra application-assisted discovery learning model. This is due to the fact that the GeoGebra program, combined with the discovery learning approach, can motivate students to take a more active role in problem-solving. Students can investigate, test their own skills, and turn their interests into solutions.

As a result of using the discovery learning paradigm, students are able to increase their IQ, expand their knowledge base, and solve problems on their own, all of which contribute to better academic performance (Siregar et al., 2020) . To help students grow as thinkers and writers, a discovery learning approach is a great place to start (Yulianto et al., 2022) . However, discovery learning also has drawbacks. One of these is the need for thorough preparation from students, as this method requires in-depth understanding (Gani et al., 2021) . On the other hand, others argue that the long learning process is a weak point of discovery learning. (Khasinah, 2021) .

Six steps form the discovery learning model: stimulation (or providing stimulation) in the first stage, problem statement in the second stage, data collection in the third stage, data processing in the fourth stage, verification in the fifth stage, and generalization (or drawing conclusions) in the sixth stage. (Cahyaningsih & Assidik, 2021) .

Two classes receiving different treatments participated in this trial. The experimental and control groups were given a trial run before the therapy began to ensure an even distribution of students in each group, regardless of their initial skill level. The experimental group of students was taught using a discovery learning methodology utilizing GeoGebra software, while the control group was taught using more traditional methods.

Statistics material was taught over three 30-minute sessions. The first session focused on core data measures, including the mean, median, and median. Data presentation was discussed during the second session. Measures of data distribution, namely the range, quartiles, and interquartile range, were discussed during the third session.

In three statistics learning sessions, the discovery learning methodology successfully motivated students to actively participate, think critically, and discover topics independently. GeoGebra was crucial for visualizing complex statistical ideas and exploring data. Observations and analysis showed that students were more engaged in their learning, grasped topics more quickly, and were able to communicate their findings in their own words. Statistics learning was no longer just about numbers and formulas, but rather a fun, interactive, and meaningful learning experience.

In contrast, the control class continued to follow traditional teaching methods, which emphasized teacher-led lectures and discouraged student

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interaction. Resources, example questions, and hands-on practice exercises were the backbone of the learning process. While the material was presented systematically and neatly, this approach provided little room for students to explore, independently discover concepts, or visually understand the meaning of data. Learning was more monotonous, and students appeared to quickly become bored. This was reflected in minimal interaction, limited student questions, and low enthusiasm for working on problems not directly related to the examples provided. Conventional learning also lacked engaging content, leading to students becoming fatigued or disinterested in the statistics material more quickly.

The results of the study show that compared to the traditional learning model, the *discovery learning approach* using the GeoGebra application produces superior learning outcomes. This is shown by comparing the average achievement of the two learning models: 65.47 for the *discovery learning model* with the GeoGebra application and 55.45 for the traditional learning model. Therefore, it can be concluded that the GeoGebra application influences the *discovery learning model,* which in turn influences the results of the learning process.

Sukajawa performed better on average when taught using *the discovery - learning method* than *the collaborative- learning method in the 2015/2016 academic year. The main difference between the two studies was the subject matter; the first focused on integers, while the second used statistics. Similar to how this study compared traditional* learning paradigms, this study also compared *collaborative learning approaches.* (Vahlia, 2015) .

Another study that supports this research finding is how the discovery learning approach can improve the mathematics learning outcomes of class XI IPS students at MAN Kota Jambi. This study utilizes the discovery learning approach and focuses on statistics, in contrast to previous studies that focused more on matrix material and did not use a discovery learning program. Because high school students' cognitive development and abstract thinking abilities are greater, junior high and high school students differ in many ways, including the research setting. Therefore, this study applies it to the junior high school level to explore how this learning model is used, which may present different challenges and needs. (Fitriyah et al., 2017) .

Conclusion and Suggestions

The research findings show that, and to a significant degree, this contradicts it, indicating that the traditional learning paradigm and the *discovery learning approach* assisted by the GeoGebra program provide different outcomes for students. Based on the learning outcomes, it can be proven that the experimental class outperformed the control class. Specifically, the average learning outcome using the discovery learning model assisted by the GeoGebra application was 65.47, while the average learning outcome using the conventional learning model was only 55.45.

Here are some suggestions for readers: 1) The GeoGebra application can help instructors use the discovery learning paradigm, which is an alternative approach to education that has the potential to improve student achievement. In order for students to understand the material, it is important to incorporate the discovery learning process of LKPD into the learning process. 2) It is expected that

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students will be able to maintain a strong understanding of the content and meet learning objectives. In addition, it is anticipated that they will be highly motivated to apply what they learn in GeoGebra to other subjects, which fosters their creativity. 3) This study only compares with the usual learning paradigm, according to previous research. For future researchers, it is advisable to use comparisons with other learning models. This study uses statistics as the subject matter, therefore it is better for future researchers to use subjects that are more suitable for the GeoGebra application, such as geometry and so on.

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