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Analysis HOTS Problem Solving: Student Learning Outcomes from Student Facilitator and Explaining and Geogebra-Assisted Discovery Learning Models

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ABSTRACT

Educators need to think about the difficulties that students often face when faced with high-order thinking skills in order to improve the teaching and learning system through the use of the right learning methods. This study aims to compare learning outcomes between using the Student Facilitator and Explaining the learning model with Discovery Learning powered by Geogebra to help students be critical, creative, and innovative in solving problems in the form of High Order Thinking Skills questions to think about in the context of science and everyday life. This experiment uses quantitative methods and is conducted in two classes XI with a total of 32 samples, namely 13 students of Experiment A and 19 students of Experiment B. This study uses instruments in the form of HOTS questions, consisting of 5 descriptive questions with pre-test and post-test designs so that the generated data is tested with JASP and SPSS software. In the Geogebra-powered Discovery Learning model, the p-value is 0.059 with an average of 20.000, while in the Geogebra-powered Student Facilitator and Explaining learning model, the p-value is 0.276 with an average of 52.947. Thus, the learning model suitable for the application of Geogebra software is Student Facilitator and Explaining based on the generated data and has a higher learning outcome value than the pre-test and post-test of the Discovery Learning learning model. This research can be a reference for education in education because of the need for proper technology to support the teaching and learning activities for students.

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1. INTRODUCTION

Education is one of the most important means of building quality human resources to move a country forward. According to Alpian et al. (2019), education has a crucial role in enhancing individuals' self-competence to address the developmental problems of an increasingly modern era effectively. Education is crucial for individuals to overcome societal stagnation since it cultivates holistic

development and encompasses knowledge, behaviour, and moral integrity. Mathematics education is a part of national education that plays an influential role in developing students' thinking skills (Indah Perawansa et al., 2019). According to Janah et al. (2019), mathematical literacy refers to the capacity to utilise and comprehend mathematics in diverse situations in order to successfully address real-life challenges. In order to foster an individual's awareness and comprehension of the practical application of mathematics in daily life, the acquired knowledge can prove beneficial both personally and for others. Education necessitates the presence of suitable facilities and infrastructure, such as schools, as they significantly influence students' teaching and learning activities (Padlan et al., 2022). Schools typically have a set of mandatory topics, with mathematics being one among them. Mathematics is a ubiquitous subject that is taught to students at all levels of education, ranging from elementary school to high school and even college. The term "math" encompasses several interpretations based on the individual's viewpoint. Due to the continuous advancement of science and technology, mathematics has become an essential and fundamental discipline that must be acquired by all individuals. This is because mathematics is intricately intertwined with human existence.

Mathematics is an arithmetic science that contains symbols and numbers. Symbols and numbers are a universal language that serves as a tool for communication in mathematics. Therefore, mathematics plays a very important role in everyday life as a tool for the development of mathematics itself or the application of another scientific field (Fauziyah et al., 2022). Mathematics is also a standard subject that must be assessed when pursuing a higher level of education. Therefore, the hours of instruction in mathematics are higher than in other subjects, since it has great potential to do its job, providing competent human resources, critical and logical thinking, initiative and creativity towards changes and advancements in knowledge. Although mathematics is a very important and widely taught subject in schools, students' desire to learn mathematics remains low (Desty Sugiharti et al., 2019). Because they find math to be a difficult and boring subject, when working on high-order thinking skill-type questions, there are still many errors in the solution.

Indonesia is one of the countries that was the subject of TIMSS from 1999 to 2015, during which period the average score of Indonesian students in mathematics was still low, putting it in the Low International Benchmark category, showing that Indonesian On average, students are only able They are unable to recognize a basic set of information, but are unable to communicate, relate different subjects, or even apply complex and abstract mathematical concepts (Prastyo, 2020). It is influenced by various factors such as Students' lack of interest in mathematics, weak basic numeracy skills, low understanding of mathematical concepts, poor understanding of symbols in mathematics, lack of discipline, lack of motivation to learn, and lower teaching methods and learning opportunities (Oktaviani et al., 2020). So that it becomes a benchmark by educators that the world of education is not just channeling knowledge but also educating and motivating so that the formation of forward-thinking and developing humans who will create something useful for the world of education, especially in mathematics requires high focus when analyzing it.

High Order Thinking Skills (HOTS) is a high-level thinking skill in students that requires critical, logical, reflective thought patterns and connections between previously received information to find a solution to a problem (Lihu et al., 2019). Higher-order reasoning skills are important in mathematics education because students need to be good at mathematics since there is a correlation between higher-order reasoning skills and student learning outcomes in every respect (Tambunan, 2019). To enable students with HOTS skills to analyze problems, evaluate, and create innovation in solving problems. HOTS are needed in science learning and everyday life (Ichsan et al., 2019) in various ways, one of which is the use of technology-enabled media. In addition to the development of science in the age of globalization, technology is one of the media for knowledge transfer and Polyas Theory. According to Polya, there are several stages in the problem-solving stages, namely: understanding the problem; developing a solution plan; solving the problem according to the plan; and reviewing the results obtained (Sutisna et al., 2023). In this way, the solution is also systematically organized with the help of technology. Technology is needed to support the teaching and learning process, especially given the

various changes over time, as students get bored if they are constantly being taught with the same teaching method, even if the material being acquainted with is not well understood. According to (Anditiasari, 2020) the teacher plays an important role in learning. The use of appropriate methods makes it easier for students to understand the material and reduces students' boredom in the classroom, and when the learning methods used by teachers are not good, they can affect students' learning. Unlike education in the past, it was relatively easy to make children obedient and easy to lead. Although the function of education was lame and played more of an educational role in the school environment, but the results were quite satisfactory in children's character formation and personality good. While in the current conditions, the role of the educational environment, family and society must be used to the maximum. In order to keep up with corruption, a transformation of education must also be imperative.

Technology, especially computers, has various software that can be used as a medium to connect abstract math inspiration with concrete math inspiration like Geogebra. Geogebra is geometry software that can solve algebra and calculus by constructing points, vectors, and abstract mathematical concepts so that they can be visualized and solved quickly, accurately, and efficiently (Tamam & Dasari, 2021). Meanwhile, according to Simbolon (2020), Geogebra is a dynamic, free, and cross-platform math software that combines geometry, algebra, tables, graphs, statistics, and calculus in one simple package and can be used for all educational levels to help students understand abstract math material visually understand. Dynamic means that users can create interactive math applications. Free means it is free to use and contains open-source software, so anyone can change or improve the program.

Multiplatform means Geogebra is available for all computer types and different computer systems like Windows, Mac OS, and Linux (Nazhifah & Rosiyanti, 2021). Some of the benefits of the Geogebra program in learning mathematics are as follows: a) Ability to create geometry drawings, even complex ones, quickly and accurately; b) Animation capabilities and manipulation Movements can provide a visual experience in understanding geometry concepts; c) Used as evaluation material to ensure that the geometry painting created is indeed correct; d) Facilitate the exploration or representation of the properties that apply to a geometry object, so students get a real visual experience and the resulting Geogebra painting can be used as assessment material (Hamidah et al., 2020). This proves the importance of the role of learning media for students to balance the evolution of time, technology, and science trials. The learning media is one of the teaching tools for teachers to impart teaching materials, increase students' creativity and increase students' attention in the learning process, because the use of media makes students more motivated to study, and encourages students to write, speak, and imagine, which stimulates more stimulation. In this way, learning media can make the teaching and learning process more effective and efficient and create a good correlation between teachers and students (Firmadani, 2020).

As for the name of the learning model, learning model is a guide for educators in planning learning in the classroom, starting with the preparation of learning tools, media, and tools, ending with assessment tools that lead to efforts to achieve learning goals (Mirdad, 2020). Learning models play an important role in teaching and learning activities because they make it easier for students to gain in-depth knowledge of the subject matter. Also, the learning model used has to be good and in tune with the students, especially through the use of more and more sophisticated technological developments that can be used in the learning process. The use of this sophisticated technology will involve students more actively in the learning process by taking advantage of learning media such as the internet, mobile phones, and laptops, so the role of the educator has shifted from being the sole source of knowledge in the classroom to a facilitator. (Hanifah et al., 2019). However, the reality emerging for next-generation students has not resulted in improved learning outcomes, particularly in mathematics. This is because the use of mathematics learning models has not been maximized as expected, as there are still many teachers who have not applied mathematics learning models, which should be used as much as possible to help students understand mathematical concepts to facilitate. Nurhasanah & Luritawaty (2021) say that educators should be able to use learning processes that move learners towards independence, broader knowledge, and lifelong learning. The learning environment that teachers create must

encourage reflective thinking, critical evaluation, and useful ways of thinking. Therefore, in this study, two learning models are applied to measure student learning outcomes with the help of Geogebra software as a form that students know the latest technologies and science that can be useful in learning and in everyday life.

This research combines Geogebra-powered learning media with Student Facilitators and Explaining and Discovery Learning learning models to generate data where Student Facilitator and Explaining (SFAE) is a learning model that makes students more active in learning by conveying statements or ideas and interacting with each other about the material they do not understand (Putra et al., 2021). Instruct students in cultivating optimal attitudes to enable them to exhibit proactive and innovative behaviour across many scenarios. The Discovery Learning Model is a specialized approach that enables students to uncover concepts and principles through their cognitive processes. This learning paradigm prioritises the teacher's role in introducing the problem to the students. Students are then asked to solve the problem through experimentation, collecting data, analyzing, and drawing conclusions (Salma & Sumartini, 2022). Starting from the explanation of the two learning models, researchers use Geogebra software as a learning medium.

There are several studies related to what researchers are researching, such as (Fitriani et al., 2022; Anjarwati et al., 2022; Subagio, Lilik, Karnasih, 2021). In this study, the student's motivation to learn increased after treatment with a learning model that was carried out in two classes using different models. A learning motivation questionnaire is used as an instrument. Nawir et al. (2019) The learning outcomes of mathematics taught using the Student Facilitator and Explaining the Cooperative Learning model became effective after treatment of the learning model, and a quasi-experiment was used in this study. Ritonga & Maryanti (2023). The use of the Student Facilitator and Explaining learning model has an influence on math learning outcomes, and it contains various factors that can affect student learning outcomes. Teachers, learning activity situations, and learning institutions have a major impact on learning activities. The low learning outcomes in mathematics are also because students are not motivated to learn mathematics, since mathematics is considered to be difficult to understand and boring lessons, and the questions asked do not improve mathematical thinking skills. Therefore, efforts are made to learn math to eliminate negative perceptions as a student by understanding math concepts and using effective learning models. This can facilitate teaching and learning activities so that students can achieve good learning outcomes. This shows that learning models play an important role in learning and also technology as a learning medium so that students are not as outdated as students in urban areas who are familiar with technology. This study contains a different learning model from previous researchers, using technology in the form of Geogebra software as a tool in learning so that students have knowledge related to the software and its use in mathematics.

This study aims to demonstrate that learning models can impact student learning results and emphasise the significance of educators' involvement in enhancing student learning through technology-enabled media like Geogebra. To assist students in developing critical thinking skills when addressing higher-order thinking Skills (HOTS) challenges. Hikmah (2020) found that pupils who comprehend Geogebra media demonstrate superior critical thinking skills compared to those who follow traditional learning methods. Geogebra is utilised in several mathematics courses like calculus, geometry, functions, and algebra, and it is not limited to linear subjects (Hamidah et al., 2020). Student success hinges on the teacher's instructional methods, as learning is a lifelong process that occurs in individuals of all ages. It can be understood as developing a person's abilities, skills, and attitudes through a mental activity that interacts with the environment and leads to changes in attitudes. Change is a relative, continual, and permanent phenomenon. Knowledge plays a crucial role in a child's life and is cognitively significant for various elements such as social, emotional, and ethical development. Student learning outcomes can be assessed using a technique known as a learning outcomes exam. Learning outcomes refer to the changes in students across cognitive, emotional, and psychomotor domains (Ratu et al., 2022). This study specifically examines the cognitive domain within the notion of

learning outcomes. Hence, the learning paradigm utilised by researchers with Geogebra software affects both research probationers and non-probationers.

2. METHODS

This study employs quantitative research methodologies. The quantitative method is a scientific approach that adheres to specific scientific principles, including empiricism, objectivity, measurability, rationality, and systematicity. Quantitative methods, also known as discovery methods, are employed to uncover and advance novel approaches by using research data presented in numerical form and subjecting it to statistical analysis. Figure 1 illustrates the use of two samples and the subsequent research stages.

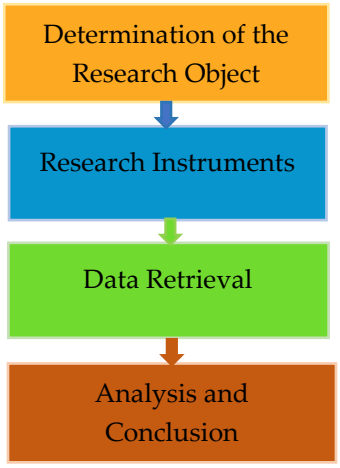

Figure 1. Research Procedure

The research phases presented in Figure 1 above can be explained as follows.

1. Determination of the Research Object
   The population is the entire subject to be measured, the examined unit. The subject of the investigation is class XI students, with a total of 32 students, from the experiment class A there are 13 students and from experiment class B, there are 19 students.
2. Research Instruments
   The instrument used in this study is a high-order thinking skill question consisting of five descriptive-type questions. The question to linguists and material experts is then validated using various assessment aspects. Starting with using language consistent with elaborated orthography (EYD), sentence structures that are clear and easy to understand so that they are free of ambiguity, and correct punctuation. Since two Geogebra-supported learning models were used in this study to progressively determine student learning outcomes, a Learning Implementation Plan (RPP) was required to help ensure that teaching and learning activities take place systematically as desired.
3. Data Retrieval
   The research employed a pre-test-post-test control group design, comprising two experimental classes: Experiment class A, which received the Discovery Learning model with Geogebra support, and Experiment class B, which received the Student Facilitator and Explaining model. This is Table 1. The research strategy involves comparing the control group's performance before and after a test, while also implementing different learning models as therapy.

Table 1. The Research Design of Pre-test Post-test Control Group

Group	Pre-test	Treatment	Pos-test
Experiment Class A	O_1	X_1	O_2
Experiment Class B	O_3	X_2	O_4

Description:
X_1: Learning with the Discovery Learning model
X_2: Learning with the Student Facilitator and Explaining learning model
O_1: Results of the Experiment Class A pre-test
O_2: Results of the Experiment Class A pos-test
O_3: Pre-test results for the Experiment Class B
O_4: Pre-test results for the Experiment Class B
Analysis and Conclusion

This study uses quantitative research methods, and data samples are taken from two classes, namely Class XI Experiments A and B. The data were then analyzed using JASP software with paired-sample t-test analysis techniques, descriptive tests, data normality tests, and homogeneity test with SPSS. From the analysis, conclusions can be drawn about the Geogebra-supported learning model and whether it influences the learning outcomes of the students after and before the treatment.

3. FINDINGS AND DISCUSSION

The research was carried out in three distinct stages: a pre-test, the implementation of Geogebra's software-assisted learning paradigm, and a post-test to collect data. HOTS descriptive-type questions pertain to linear programme material that aims to foster critical thinking skills and encourage students to make connections with real-life situations. The experiment conducted by class A implemented the Discovery Learning instructional approach with a cohort of 13 students. The highest score achieved in the pre-test was 15, whereas the highest score attained in the post-test was 30. The experiment, conducted by class B, implemented the Student Facilitator and Explaining learning paradigm with a cohort of 19 students. The maximum pretest score is 52, while the posttest score is 78. The pretest results of experiment classes A and B exhibit a disparity, leading to the initial assumption that experiment B surpasses experiment A.

3.1 Descriptive Pre-test Results

Table 2. Pretest Descriptive

	N	Mean	SD	SE
X1	13	8.538	3.503	0.971
X2	19	28.368	6.405	1.469

In Table 2, there is an experiment class A mean of 8.538 with SE 0.971 and a experiment class B mean of 28.368 with SE 1.469, so from the data in Table 2, it can be said that the experiment class B is still superior to the male class. Furthermore, the data was generated after analyzing the two classes' post-test data to find out which learning model can influence student learning outcomes.

Experiment classes A dan B have different sample sizes because they use two different classes, so with Geogebra-powered Discovery Learning learning model treatment, the experiment class A has a mean of 20.000, a variance of 66.333, a kurtosis of 1.655, a minimum of 7.000, a maximum of 30,000, and a P-value of 0.059 , while the experiment class B with the Student Facilitator and explanation of learning model treatment has a mean of 52.947, a variance of 80.386, a kurtosis of 1.949, a minimum of 30.000, a maximum of 72.000, and a P-value of 0.276, as shown in Table 3.

Table 3. Descriptive Statistics of Posttest

	X1	X2
Valid	13	19
Missing	6	0
Median	23.000	53.000
Mean	20.000	52.947
Std. Deviation	8.145	8.966
Coefficient of Variation	0.407	0.169
Variance	66.333	80.386
Skewness	-0.404	-0.390
Std. Error of Skewness	0.616	0.524
Kurtosis	-1.655	1.949
Std. Error of Kurtosis	1.191	1.014
Shapiro-Wilk	0.874	0.941
P-value of Shapiro-Wilk	0.059	0.276
Minimum	7.000	30.000
Maximum	30.000	72.000

3.1.1 Data Normality Test

Table 4. Normality Test (Shapiro-Wilk) Posttest

			W	P
X1	-	X2	0.890	0.098

Note. Significant results suggest a deviation from normality.

Table 4 explains that if the p-value > 0.05, the data at 0.098 is normal, because if <0.05 H_0 is rejected and the data are not normally distributed, they must pass through the Wilcoxon signed rank -Test to be replaced. If the data are normal, it means that there are changes before and after the treatment in the class using.

3.1.2 Homogeneity Test

Table 5. Homogeneity Value

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Mathematics Learning Results	Based on Mean	.483	1	30	.492
	Based on Median	.212	1	30	.649
	Based on the Median and with adjusted df	.212	1	28.181	.649
	Based on trimmed mean	.433	1	30	.516

Table 5 displays the posttest value of experimental classes A and B, which is 0.516. If the significance value (sig) based on the mean is greater than 0.05, then the data is considered homogenous. Conversely, if the significance value (sig) based on the mean is less than 0.05, then the data is considered non-homogeneous. Since the p-value is greater than 0.05, we can conclude that the data on student learning outcomes is homogeneous.

3.1.3 Hypothesis Test

Table 6. Post-test sample T-test

Measure 1		Measure 2	T	df	P	Cohen's d
X1	-	X2	-11.999	12	< .001	-3.328

Note. Student's t-test.

Table 6 shows a Cohen's d value representing the difference between the experiment classes A dan B items of 3.328. Normality test performed using the Shapiro-Wilk test. The research hypotheses to be tested are: $H_0 =$ There is no difference between the data before and after the treatment. $H_1 =$ There is a difference between the data before and after treatment (Lu et al., 2020).

- H_0 is accepted, H_1 is rejected if $P \geq n$
- H_0 is rejected, H_1 is accepted if $P \leq n$

The results of the data analysis between the two classes differ significantly, in terms of the number of students, the learning models, gender, and class atmosphere, as well as the classroom equipment. The experiment class A treating the Geogebra-supported Discovery Learning model has a mean of 20.000, a median of 23.000, a coefficient of variance of 0.407, a Shapiro-Wilk score of 0.874, a minimum score of 7.000, a maximum score of 30.000, and a P score of 0.059 > 0.05, so it is normally distributed, while the experiment class B, using the Student Facilitator and the explanation of the learning model treatment, had a mean of 52.947, a median of 53.000, a coefficient of variance of 0.169, a Shapiro-Wilk score of 0.941, a minimum value of 30,000, a maximum value of 72.000, and a P-value of 0.276 > 0.05, so it is normally distributed. And has a Cohen's d value of 3.328. The two classes have different values, but both are normally distributed.

Testimonials from previous researchers state that the Discovery Learning learning model, powered by the Android version of the Geogebra program, increased student problem-solving ability on linear program material, with final test scores exceeding 80% in the second cycle, with an average score of 83.6. In the first cycle, the proportion of classically graduated students was only 28%, with an average of 58.28. There were students with scores of 80 (Djumanan, 2021). This means that there is a change after the implementation of the learning model supported by the Android version of Geogebra software. Based on the study conducted by Ritonga and Maryanti in 2023, the data analysis of hypothesis testing indicates that the average value of the pre-test data is 47.17, while the average value of the post-test data is 85.33. A t-test was performed to investigate the impact of the Student Facilitator and explain learning model on student learning outcomes in mathematics. Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, indicating that the students' mathematics learning outcomes are influenced by the implementation of the Student Facilitator and Explaining learning paradigm. Upon applying treatment to the learning model, there is a noticeable augmentation.

The average score of the discovery learning type cooperative learning model is 64.36, which differs from the research findings of (Thelessy et al., 2022). The mean score of the student facilitator and explainer type cooperative learning model is 49.80. There are disparities in the educational achievements of Grade VII pupils who are instructed using the discovery learning model against the student facilitator and explanation learning model when studying linear equations and inequalities of one variable. This is reflected in the results of the t-test calculation, namely the value of Sig. (2 - tailed) = 0.000 < the value of = 0.05, resulting in H_0 being rejected and H_1 being accepted. These examples clearly demonstrate that each research study faces its own set of problems, as the educational institutions themselves also impact students' learning outcomes. Furthermore, the advancement of modern science necessitates that students adapt to these advancements.

Previous studies show that after the treatment of learning models, there are changes in students, both in terms of their cognitive and learning motivation. In addition, complete facilities are also required in a school. Complete facilities help students learn, while incomplete or non-existent classrooms mean that students often do not focus on what the teacher is explaining because there are many objects to see. The spirit of learning is also required to achieve good learning outcomes for

students. Schools need to meet students' needs as much as possible, support the teaching and learning process, and educate students who can think critically and are motivated to learn, as the school environment can influence the way students think. Whether a learning model is appropriate or not depends on how willing teachers and students are to learn in a way that teachers design well. Because good cooperation between teachers and students can result in something good. The importance of critical thinking must also be realized by the students as they encounter different kinds of problems. Citing Kurniawati & Ekayanti (2020), critical thinking is very important because students with critical thinking skills can solve the problems they face. Education must be able to leverage advances in technology and science to achieve educational goals effectively and efficiently (Rahmi & Samsudi, 2020). Since the use of technology can also be helpful in the teaching and learning process, there is a need to facilitate all elements in the school so that there are no outdated elements.

4. CONCLUSION

The Geogebra program has a noticeable impact on students' academic performance both prior to and following its implementation in the learning paradigm, as indicated by the discussion and research results. When comparing experimental classes A and B, it was found that experimental class A, which includes a student facilitator and explains the learning paradigm, shows the highest value. It is important to stay updated on technological innovations to enhance learning and provide institutional support for a smooth teaching and learning process. Proficiency in Geogebra software helps enhance students' abilities and competence in addressing complex reasoning problems. The researchers believe that there is ample room for improvement in this study, ranging from the instruments used to the selection of students and schools, which are the focus of the research. It is acknowledged that the choice of a particular school can significantly influence the study's outcomes. By utilising technology-driven research, you can independently gather all the essential resources without relying on educational institutions. Researchers are discontented with this research due to several reasons, including the lack of accessible facilities at the school, which hinders students from implementing the Geogebra software-based learning approach. For future researchers seeking to conduct additional investigations in this area, it is recommended to carefully select a study site equipped with advanced tools capable of facilitating research.

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