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DIFFERENCES EFFECT OF THE APPLICATION THE DISCOVERY LEARNING AND PROBLEM BASED WITH GEOGEBRA TO IMPROVE CRITICAL THINKING ABILITY

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Abstract*: The purpose of the research know and analyze the different effects of the application of Discovery Learning and Problem Based Learning (PBL) models administered by Geogebra to improve students' critical thinking. The research method used was trial research applied to two classes with a Discovery learning and Problem Based Learning (PBL) model, each of the learning assisted by Geogebra. The research results were analyzed using descriptive and inferential analysis. The first trial class's average critical thinking ability was 82, and the second practical class was 84.64, more significant than the specified Minimum Completeness Criteria (MCC), 70. Based on the results of the descriptive study. So that Discovery Learning and Problem Based Learning with Geogebra positively influence students' critical thinking skills. But, there is no difference in the practical application of the two learning models.*

Keywords*: Discovery Learning, Problem Based Learning, Geogebra, Critical Thinking*

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Introduction

Mathematics is one of the subjects that are always related to our life's problems because mathematics trains students to communicate with numbers, be logical, structured, critical, creative, and objective. Mathematics becomes the most crucial subject in the development of science technology (Yadav, S. 2019; Wang, M. T., & Degol, J. L. 2017; Marmon, M. 2019). The scientific approach with student center characteristics in implementing the 2013 curriculum is intended to achieve the objectives of learning mathematics (Gunawan, I. 2017; Muhammad, et.al., 2022). Mathematical goals will be completed and can meet the reasoning ability. The steps of reasoning in mathematics are essential, critical, and creative thinking (Winarso, W., & Haqq, A. A. 2020). The achievement of mathematics learning objectives is intended so that students can face advances in science and technology. This is stated in the content standards for elementary and secondary education units, which say that mathematics subjects need to be given to all students to think creatively, critically, independently, collaboratively, and communicatively (Urbani, et.al., 2017). Higher-order thinking skills are an essential requirement for meaningful learning. High-order thinking skills or High Order Thinking Skills (HOTS) are necessary for every participant. One of the things that support students' HOTS abilities is thinking critically (Panggabean, E. M., et.al., 2022).

Students can achieve mathematical goals if mathematical skills are met, including the ability to think critically. And can gain the ability to think critically if the teacher activates students in learning, constructs finds, and develops their abilities. The ability to think critically can make students more skilled in composing arguments, checking the credibility of sources, or making problem-solving decisions, drawing conclusions from various possibilities, and solving everyday problems systematically with the best solutions (Tripathy, M. 2020; Irvan & Muslihudin, 2020). However, even though students' critical thinking skills are one of several abilities that students must have, in reality, these abilities have not been appropriately mastered by students. The preliminary study found that the students' critical thinking of Indonesian was still low. This is consistent with research that states that only 49% of junior high school students in Bandung achieve the ideal score for critical thinking skills (Al Ghifari, S. S., & Sudihartinih, E. 2021). On an international scale, Indonesian students had an average of 10% correct answers in one math contest. At the same time, the global average reaches 23% (Handayani, et.al., 2020). The data from Trend In Mathematics and Science Study (TIMSS) Indonesia has 41 out of 45 participating countries (Fenanlampir, et al., 2019).

Table 1:The Average Percentage of Indonesian Students' Correct Answers in TIMSS 2011

Aspects of the Cognitive Process Domain	Average correct answers (%)	
	Indonesia	International
Knowledge	31	49
Application	23	39
Reasoning	17	30

From the data in table 1, it can see that Indonesian students' reasoning ability has a difference of 13% compared to the international average and knowledge and application. It has a difference of 16% and 18% from the global average. The same thing also happened at SMK Negeri 1 Kutalimbaru, where the critical thinking skills of the two classes, 48% and 50% of students, were declared complete from the Minimum Completeness Criteria (MCC) on linear program material as presented in table 2 below:

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Table 2: Mathematics learning completeness of SMK Negeri 1 Kutalimbaru

Number	Class	MCC	Number of Students Who Completed	Number of Students Who Didn't Complete	Percentage of students who completed	Percentage of students who Didn't complete
1	X 1	≥ 70	18	18	50%	50%
2	X 2	≥ 70	15	21	42%	48%

From the results of the students' answers, it appears that the incompleteness occurs due to several reasons, including; students do not recognize mathematical problems, especially those that require critical thinking skills, students do not understand mathematical symbols, which in the end, students make mistakes in the process of answering questions. Reforms are needed that can increase student learning participation to overcome the existing problems. One of them is using the Discovery Learning and Problem Based Learning (PBL) models with Geogebra.

Furthermore, the development of digital technology is so advanced that positive benefits bring many conveniences for us today in solving various problems that arise. There is an application that helps us to determine the translation and rotation points of a point or object, especially in the discussion of Geometric Transformation material, namely Geogebra (Rahadyan et al., 2018). Geogebra is a dynamic math software that combines geometry, algebra, and calculus can be used as aids in learning mathematics. This is also in line with the opinion of being a computer program that is very dynamic and interactive in supporting learning and solving mathematical problems, especially geometry, algebra, and calculus (Suhaifi et al., 2022).

Discovery is a learning model that focuses on the process of developing student learning methods, activates students, is student-oriented, where students find themselves, investigate themselves, and always emphasize student self-development (Willegems, et.al., 2018; Tanjung et al., 2020; Gencoglu, et.al., 2023; and Hartono et al., 2021)

Problem-based learning is a learning model characterized by real problems as a context for students to learn to think critically and to be skilled at solving problems and acquiring knowledge (Effendi, et.al., 2019; Sihaloho, et.al., 2017; Astriani, et.al., 2017; Khairani, et.al., 2020 and Mushlihuddin et al., 2020). Another opinion says that Problem Based Learning is a learning model that emphasizes students' cognitive aspects so that student-centered learning focuses on what students think when doing the learning, not what students do. The teacher acts as a guide and facilitator to learn to think and solve problems in their way (Irvan & Muslihudin, 2020). Based on the description above, this study aims to determine the difference in the effect of applying the Discovery Learning and Problem Based Learning models assisted by Geogebra on the improvement of students' critical thinking skills.

Methods

Type of Research

This type of research is quasi-trial research with a 2 × 1 design. The population is all class X SMK Negeri 1 Kutalimbaru in the academic year 2021/2022. The sample is class X1 with the absorption of Discovery Learning assisted by Geogebra as the trial class 1. And class X2 with the absorption of Problem Based Learning assisted by Geogebra as the practical class.

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Population

This study's population was all students of class X with the number of class 12 classes at SMK Negeri 1 Kutalimbaru, and the number of students was 432 students. And the research sample came from 2 practical classes with a total of 64 students.

Data Collection Techniques

Data collection using pre-test and post-test to determine the increase in two trial classes' critical thinking skills in student learning motivation. Collected data to assess the Discovery Learning and Problem Based Learning models assisted by Geogebra to improve students' critical thinking skills.

Data Analysis Techniques

To obtain a good instrument, before using the instruments are validated by the validator and tested. Furthermore, the questionnaire instrument was tested and analyzed to determine the reliability, difficulty level of the questions, and the items' distinguishing power. Again, to assess the balance of the two trial classes, a normality test with Kolmogorov Smirnov is needed by looking at the significant number of Monte Carlo Sig. The homogeneity test uses the Levana Statistic. Hypothesis testing uses the One-Sample t-test to see the effect and the Independent Sample Test t-test to see the difference in influence with a significance level of 0.05, contained in your current template.

Result and Discussion

The data in this study is quantitative data obtained after conducting statistical tests which will be detailed in the following discussion. Research starts from conducting pre-tests, giving treatments and post tests. The collected data is then tested using prerequisite tests. After that, a hypothetical test was carried out using an independent sample t test. After conducting the prerequisite test, we can summarize that all samples come from populations normally distributed with variants from the same population. Can see the summary of the results of the normality and homogeneity tests in tables 3 and 4 below:

Table 3: Research Variable Normality Test Results

			PretestDL	PosttestDL	PrettestPBL	PosttestPBL
N			32	32	32	32
Normal Parameters[a,b]	Mean		44.69	81.72	45.16	83.91
	Std. Deviation		10.846	7.140	11.179	8.494
Most Extreme Differences	Absolute		.136	.146	.151	.145
	Positive		.114	.139	.131	.105
	Negative		-.136	-.146	-.151	-.145
Test Statistic			.136	.146	.151	.145
Asymp. Sig. (2-tailed)			.136[c]	.081[c]	.063[c]	.085[c]
Monte Carlo Sig. (2-tailed)	Sig.		.553[d]	.473[d]	.432[d]	.480[d]
	99% Confidence Interval	Lower Bound	.540	.460	.419	.468
		Upper Bound	.566	.486	.445	.493
a. Test distribution is Normal.						
b. Calculated from data.						
c. Lilliefors Significance Correction.						
d. Based on 10000 sampled tables with starting seed 2000000.						

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For a summary of the results Homogeneity test, can see it in Table 4 below:

Table 4: Homogeneity test results

	Levene Statistic	df1	df2	Sig.
PRETEST	.005	1	62	.945
POSTTEST	.906	1	62	.345

After testing the prerequisite data analysis, it found that the critical thinking ability data were normally distributed and had the same variance (homogeneous), then the analysis used was parametric. After all, variables were declared normal and homogeneous, and then the hypothesis was tested using the t one-sample test and independent-sample test. Can see the results of the t one-sample test from the two trial classes in tables 5 and 6 below:

Table 5: Results of t One-Sample Test of Critical Thinking Ability Trial class 1

	Test Value = 70			
	t	df	Sig. (2-tailed)	Mean Difference
PosttestDL	9.284	31	.000	11.719

The data from table 5 shows the number t = 9.284 > t table = 2.040. This means that learning with the Geogebra-assisted Discovery Learning model can improve students' critical thinking skills.

Table 6: Test Results t One Sample Critical Thinking Ability Trial Class 2

	Test Value = 70			
	t	df	Sig. (2-tailed)	Mean Difference
PosttestPBL	9.261	31	.000	13.906

Data from table 6 shows the number t = 9.261> t table = 2.040. This means that Problem Based Learning with Geogebra can be advance students' critical thinking.

The independent sample t-test was conducted using SPSS 23.00 for windows and to determine whether there is a difference between using Discovery Learning with Geogebra and Problem Based Learning with Geogebra on critical thinking skills in trial class 1 and trial class 2. Data is taken from the results post-test, and can see the results in Table 7 below:

Table 7:The t-test results of the Independent Sample Test for Critical Thinking Ability

		Levene's Test for Equality of Variances		t-test for Equality of Means		
			Sig.	t	df	Sig. (2-tailed)
Critical Thinking	Equal variances assumed	.906	.345	-1.115	62	.269
	Equal variances not assumed			-1.115	60.220	.269

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The result of the t-test shows that the significance value is Sig (2-tailed) is 0.269 With a significance level of 0.269 > 0.050, it means that Ho is accepted. In other words, that there is no difference between using the Discovery Learning with Geogebra and the Problem Based Learning with Geogebra on critical thinking skills in trial class 1 and trial class 2. The t value shows the number -1,115, which means that trial class 2 has an ability value. Critical thinking is greater than trial class 1.

The one-sample test for critical thinking skills with the Discovery Learning with Geogebra with SPP 23 for windows shows the number t count = 9.284 > t table = 2.040. This means that learning with the Geogebra-assisted Discovery Learning model can improve students' critical thinking skills. This is in line with a study that states that students have high category essential skills of thinking after applying the Discovery Learning model (Chusni, M. M., Saputro, S., & Rahardjo, S. B. (2021). The one-sample test of critical thinking skills with the Problem Based Learning with Geogebra with SPP 23 for windows shows the number t-count = 9.261 > t-table = 2.040. This means that learning with Problem Based Learning with GeoGebra can improve students' critical thinking skills. This is in line with the research stating that Problem Based Learning can be better at training students in critical thinking because, in the process, it is intended to lead to critical thinking *gradually* (Monteiro, S., Sherbino, J., Sibbald, M., & Norman, G. 2020). SPSS 23 for windows is used to see the difference in applying the Discovery Learning and the Problem Based Learning with Geogebra on critical thinking skills. The test results show that the significance level at 0.245 > 0.050 means that Ho is accepted. In other words, there is no difference in the effect of the application of the Discovery Learning with Geogebra and the Problem Based Learning with Geogebra on critical thinking skills in trial class 1 and trial class 2.

The t value in the table shows the number -1,173, which means that trial class 2 has a value of critical thinking skills more remarkable than the trial class 1 class of 1.173. Both learning models assisted by Geogebra have a positive effect on increasing critical thinking skills. This is in line with Brunner's theoretical research, which states that the learning process will run well and creatively if the teacher provides opportunities for students to find a rule (including concepts, theories, definitions, and so on) (Tanjung et al., 2020)".

Discovery Learning and Problem Based Learning with Geogebra have a positive effect on increasing critical thinking skills. In line with the research, it is stated that Problem Based Learning is a learning model used as a process of building and activating student knowledge and as a strategy in problem-solving developed and obtained through group discussions and research (Rahmi, N., Arnawa, I., & Yerizon, Y. 2019). Other researchers say that students who learn mathematics with the Problem Based Learning model. This learning model has a good effect and is suitable for providing variations in the learning model if adjusted to its situation. This result is in line with a study that states that Problem Based Learning assisted by Geogebra can improve critical thinking skills (Rahman, O., & Johar, R. 2021; Selvy, Y., Ikhsan, M., & Johar, R. 2020).

Can see the effect of two learning models in each trial class on critical thinking skills in Table 8 below:

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Table 8: Data on the Value of Critical Thinking Ability in the Two Trial Classes

Description	Trial Class 1	Trial Class 2
Highest Score	95	95
Lowest Score	70	70
Average	82,00	84,64

Table 8 above shows that the post-test results of the average critical thinking ability in trial I were 82.00 and the trial class II had an average of 84.64. The data shows that the average in trial class II is higher than the average in trial class I. However, there is no difference between the two classes for the highest and lowest scores.

To determine the effect seen from the aspects of classical student learning completeness and learning time. The following shows a discussion for each indicator in measuring the Geogebra-assisted Discovery Learning model's impact on learning activities.

To see the effect of a learning model, one of which is to know the level of mastery of students after applying the model. In this study, student mastery in using the Discovery Learning learning model can see students through tests of students' critical thinking skills and learning motivation. The data in table 8 shows that the classical completeness of students' critical thinking skills reaches 100%. This can see with the lowest score being 70, while the Minimum Completeness Criteria (MCC) score determined from the school is 70. Thus the post-test results of critical thinking skills in trial class 1, and trial class 2 met the criteria for achieving completeness classically.

The result of learning time achievement in trial class 1 with the Discovery Learning model with Geogebra is four meetings or 8 × 45 minutes. The same thing happened in trial 2 with the Problem Based Learning and Geogebra models. When compared with the learning carried out so far, there is no difference between learning time in the trial class 1 and 2 and the achievement of ordinary learning time. It can be seen that the learning time in the trial class 1 the Discovery Learning with Geogebra and the trial class 2) Determine the maximum and minimum value of contextual problems associated with two-variable linear programming, and 2) Solve contextual issues related to two-variable linear programming.

This is following the criteria of learning time. Namely, the achievement of learning time is at least the same as ordinary learning. Thus, the learning time in trial class 1 The Discovery Learning with Geogebra l, and trial l class 2 use Problem Based Learning with Geogebra l has been achieved.

Conclusion and Suggestions

Based on the results and discussion described in the previous chapter, several conclusions will be made as follows: 1) The Discovery Learning with Geogebra can improve students' critical thinking skills, 2) The Problem Based Learning with Geogebra can enhance necessary thinking skills, 3) There is no difference in the effect of increasing students' critical thinking skills from the application of the two learning models. Based on the research conclusions, the researcher can provide suggestions that can be summarized as follows: 1) Teachers are advised to apply learning models that are following the subject matter being taught, including the Discovery Learning and Problem Based Learning models, 2) Teachers and students are expected to be able to maximize the use of learning media IT-based such as Geogebra, 3) For further researchers, it is expected to apply the Discovery Learning with Geogebra and Problem Based Learning

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with Geogebra are different goals, such as creative thinking skills and self-confidence, learning methods to improve the quality of education, especially mathematics learning.

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