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Differences in Improving Student's Problem-Solving Mathematics Ability Using Problem-Based Learning and Discovery Learning

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ABSTRACT

This study was carried out with the aim of determining whether the improvement in the mathematical problem-solving ability of students taught by the PBL learning model was greater than students that taught using the DL learning model. In this study, the population was all class XI science students at Markus High School Medan. The type of research used is quasi-experimental research. The research samples were selected using purposive sampling techniques (selection of samples based on certain characteristics). Furthermore, randomization was carried out on the two classes selected to be designated as experimental class I and experimental class II. Class XI IPA 1 was selected as a PBL experiment class with 30 students and class XI IPA 2 was selected as a DL experimental class with 30 students. This study used the Ancova test. Based on the results of the study, it can be said that: Students who are taught using the PBL models are higher than students who are taught using the DL model with $F_{count} > F_{table}$ shows that in student's mathematical problem-solving ability there are differences, is 5.936 > 4.01.

A. INTRODUCTION

In the digital era, humans must prepare themselves to become reliable human resources to accelerate the development of the Indonesian nation in the scope of education. The existence of quality education can create human resources who have skills and expertise that can be a provision in their lives. That is why, educators and students are required to have high teaching and learning skills in order to compete in this digital era. Currently, all sources of information are available on the internet and can easily be accessed by anyone and anytime. For this reason, in order to be able to master science and technology, a person must become a qualified human resource who has morals and knowledge.

Unquestionably, mathematics plays a significant part in human life as well as the advancement of science and technology. This is consistent with Freudenthal's theory, according to which mathematics is a part of practically all human endeavours (Hasratuddin, 2018: 37). Students must be competent in order to manage the knowledge they are given in order to survive in constantly changing, competitive environments. This is in line with the four abilities that everyone should possess in the twenty-first century: the capacity for critical thought, the capacity for creative thought, the capacity for communication, and the capacity for collaboration.

Minarni (2018) added that mathematics is growing and always has a relationship with the development of science, technology and various human activities. By studying mathematics, a person is able to connect mathematics with other disciplines and with everyday life. According (NCTM, 2000) says that there are five aspects of mathematical thinking ability, namely problem-solving ability, communication ability, reasoning ability, and representation ability. Of the five aspects, problem-solving ability is considered one of the most important abilities that students must have.

But in fact, many students have difficulty in solving mathematical problems. Difficulties occur when students will get those answers. This makes it difficult for pupils to learn math, which lowers their aptitude for solving math problems. Students prefer to make some notes or memorize mathematical concepts, even if they do not understand what they memorize and take notes. Klurik and Rudnick (1998) define a problem is a situation faced by an individual who needs a solution in it, but does not immediately know how to determine the solution. Fredy (2014) states too, mathematics problems are questions that must be answered although not all questions will automatically become problems. So basically the problem in mathematics is a challenging problem but indirect answers can be obtained.

The challenges encountered at SMA Markus Medan include the fact that pupils still struggle to comprehend and solve problems intended to gauge their aptitude for solving mathematical conundrums by the use of straightforward context. To see student's mathematical problem solving skills, researchers give students a simple question about linear program questions.

The next step is for the pupils to construct a mathematical model of the equation. Students employ completion stages that, while leading to the right answer, are nonetheless lacking. The student is then instructed to reevaluate the findings, yet the students fail to accurately report the findings. The student's response demonstrates that they are unable to fully explain the knowledge and inquiry posed by the question. The standards for scoring a student's mathematical problem-solving skills at SMA Markus Medan are still low based on the average problem-solving score.

According to Saragih and Winmery (2014), students frequently give incorrect responses while solving problems because they just write down their final response before determining whether or not it is right. Because it is seen as a crucial general goal of teaching mathematics, Sumarmo (1994) states that problem solving lies at the core of mathematics. Furthermore, according to his research, the ability to organize strategies is what is required in the cognitive process while solving difficulties, since this will teach people to think critically.

How crucial a student's capacity for problem solving is to their ability to master mathematics. By implementing learning models that might advise students to practice their mathematical reasoning, teachers should work to ensure that mathematics learning objectives are met. In order to help students become better at solving mathematical problems, a learning model is required. According to Trianto (2011), the learning model is a planning tool for learning, which includes setting learning objectives and stages for learning activities. Therefore, using the appropriate learning model can revive the spirit of learning for both individual and group learning.

The PBL learning paradigm is one of the most innovative, creative, and effective ways for improving problem-solving skills. The PBL learning strategy is suited for use in classrooms to help students develop their problem-solving skills. According to Polya's (1973) model of learning phases, they are: (1) introducing students to issues, (2) organizing students to learn, (3) assisting student investigations, (4) generating and presenting work, and (5) evaluating and assessing the problem-solving process.

As argued by Arends (2008) that the basis of problem-based learning involves authentic and meaningful learning, which serves as a grounding for student questions. The PBL model requires students to actively construct mathematics concepts well, in order to generate student's confidence in the potential provided and improve student's abilities.

According to Lestari and Yudhanegara (2017), the PBL learning model prioritizes issues in students so that students may practice problem-solving skills and enhance other mathematical abilities in order to obtain new knowledge. In the PBL learning model, students are trained to actively learn in groups. A given problem is a contextual one that has to do with everyday life. Through this learning model students must solve problems and find mathematical concepts related to the lesson being studied. Through the learning stage, students can understand mathematical problems by looking for the interrelationship of concepts from the problems presented. The challenge for students is the difficulty of relating the given problem to mathematical concepts because students are not used to it.

According to Sanjaya (2011), PBL learning allows students to apply their knowledge in real-world scenarios. Furthermore, even in non-formal education, this paradigm may encourage students' interest in lifelong learning. According to Yusri (2018), PBL learning begins with a framework of real-world challenges linked to mathematical concepts, and then the instructor must encourage students to be active participants in all learning.

But not only the PBL learning model, but researchers will also apply the DL learning model to improve mathematical problem-solving skills. Sugiono (2009) DL is one of the learnings that uses invention, where students get the knowledge that will be understood to get guidance from the teacher, such as through questions, demonstrations or other media. According to Pasaribu, Surya, and Syahputra (2016), the DL model is a learning process that has been designed to reach concepts, where later students become observing, understanding, making conjectures, and analyzing so that they can construct and discover general principles for themselves with teacher instructions in the form of directing questions.

The advantage in DL learning is that the role of students is too large in the method of discovery because learning is no longer centered on the teacher but on the student. By accustoming students in problem solving activities, it can be expected to increase student's ability to do math problems, because students are involved in mathematical thinking when conducting experiments and solving problems (Markaban, 2006). Additionally, According to Amalia, Surya, and Syahputra (2017), implementing the PBL paradigm enhances students' problem-solving skills more than traditional teaching approaches. Pupils who were taught utilizing a PBL approach outperformed students who were taught using traditional teaching techniques on exams, demonstrating this. According to Dahar (2011), the capacity of knowledge to stick around in students' memory for a long time, a greater transfer impact than other learning outcomes, and an overall development in students' arithmetic and reasoning abilities are only a few benefits of learning via discovery.

This is what motivates researchers to conduct research on "Differences in Improving Students' Mathematical Problem Solving Ability through Problem-Based Learning and Discovery Learning Models"

B. RESEARCH METHODS

This study was done in class XI at SMA Markus Medan. This study was carried out during the fourth semester of the academic year 2021–2022. There has never been the study of this kind done in this school's linear program lessons, therefore that is why it is being done there now.

The purpose of this research is to compare students who are taught using the DL and PBL learning models to see which group improves their ability to solve mathematical problems. The study's research approach is a quasi-experiment in which individuals are not grouped at random but the researcher accepts the subject's condition (Ruseffendi, 2005).

The entire class of XI students at SMA Markus Medan made up the study's population. Purposive sampling was the method used in this study's sample process. Class XI IPA 1 was chosen as the experiment class I, and class XI IPA 2 was chosen as the experiment class II. Each experiment class had 30 students. The research procedure is carried out in this study, presented in the form of steps or research flow such as Figure 1.

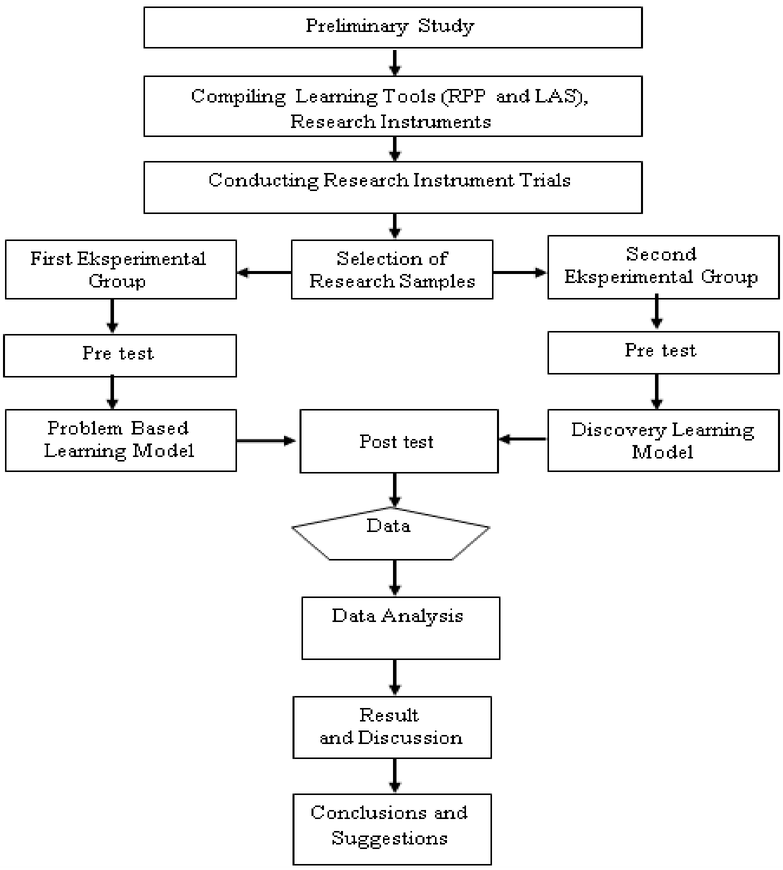

Figure 1. Research Procedure

In data gathering methods, test instruments such as before and after tests on mathematical problem-solving ability are utilized. Inferential statistical analysis is used in data analysis. The mean, standard deviation, maximum and lowest values of the pre-test and post-test data of mathematical problem-solving abilities are calculated in the first stage of the descriptive analysis phase.

The post-test data are submitted to the normality and homogeneity test, which is the necessary analytical test, in the second step, and the hypothesis test in the third stage. The Ancova is used to test statistical hypotheses. The Ancova inferential technique is used to compare the average test scores of pupils who learnt mathematics using the PBL learning model and those who learned it using the DL learning model. The statistics utilised in this investigation are listed below (Kadir, 2010: 413):

$$Y_{ij} = \mu + \tau_i + \beta\left(X_{ij} - \bar{X}_t\right) + \varepsilon_{ij} \quad (1)$$

where: i = 1, 2; j = 1, 2, 3
Information:
Y_{ij} = post-test score of problem-solving skills of the j-th students, who get i-th learning.
μ = average score of the student's post-test
τ_i = the effect of i-th on learning outcomes
β = a regression coefficient indicating Y_{ij} dependence on X_{ij}
X_{ij} = pre-test score of problem-solving skills of j-th learning produced on i-th learning related Y_{ij}
$\bar{X}_t$ = an average student pre-test scores
ε_{ij} = components of errors that arise in the j-th student of the i-th learning

C. RESULT AND DISCUSSION

1. Pre-Test Results of Student's Mathematics Problem-Solving Ability

To get an idea of the student's pre-test score, the calculation of the average and standard deviation are carried out. Thes the following table presents the summary results.

Table 1. Description of Pre test Score Student's Mathematical Problem Solving Ability

Research Sample Class	Pre test Student Ability			
	Min. Score	Max. Score	Mean	Standard Deviation
Experiment Class I (Problem-Based Learning)	34	68	47,67	9,03
Experiment Class II (Discovery Learning)	38	70	50,53	7,01

It is important to be aware that PBL and DL classes only allow for a maximum score of 100. Students in PBL lessons must acquire a minimum pre-test score of 34 and a maximum pre-test score of 68 in order to demonstrate their ability to solve mathematical problems.

2. Post Test Results of Student's Mathematics Problem Solving Ability

The post-test aims to see students' mathematics problem-solving skills after being provided with PBL learning and DL learning. In order to get an idea of the student's post-test score, an average calculation and standard deviation are carried out. The results are shown in Table 2.

Table 2. Description of Post-test Student's Mathematics Problem Solving Ability

Research Sample Class	Post test Student Ability			
	Min. Score	Max. Score	Mean	Standard Deviation
Experiment Class I (Problem-Based Learning)	58	88	77,13	8,08
Experiment Class II (Discovery Learning)	58	86	73,60	7,99

The fact that PBL and DL classes only allow for a maximum score of 100 should not be overlooked. The minimum and highest average post-test scores for students in the PBL class for their aptitude to solve arithmetic problems are 58 and 88, respectively. For students in the DL class, the lowest and highest average post-test scores for their ability to solve mathematical problems are 58 and 86, respectively. The average pre-test score for experiment class I is greater than the average post-test score for experiment class II, as can be observed.

Figure 2 shows an overall comparison of each indicator of students' aptitude for solving mathematical problems who were exposed to the PBL and DL learning models.

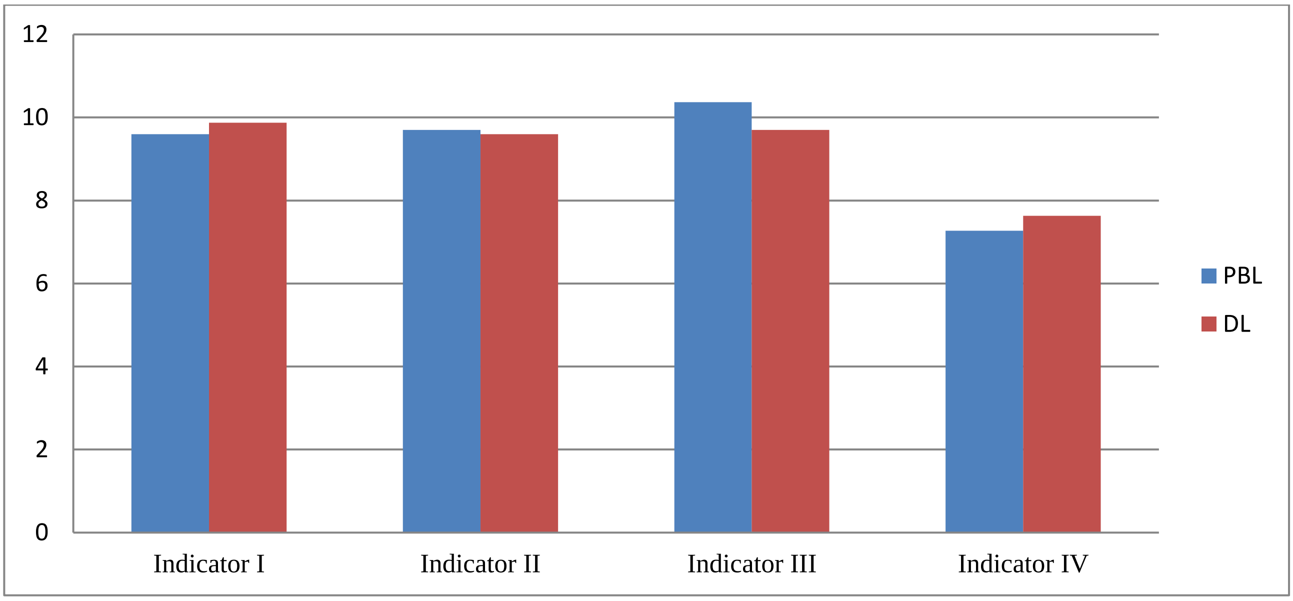

Figure 2. Graph of Student's Mathematical Problem-Solving Ability on each Indicator

Figure 2 illustrates that students who are taught using the PBL learning paradigm have an advantage in indication III, which is problem-solving, but a shortcoming in indicator IV, which is re-examination. Meanwhile, students taught using the DL learning model have an advantage in indication I, which is issue understanding, but a disadvantage in indicator IV, which is checking again.

3. Normality Test Data of Student's Mathematical Problem-Solving Ability

The test for normality is used to ascertain whether or not the post-test results of students' aptitude for solving mathematical problems after PBL and DL learning are regularly distributed. The Kolmogorov-Smirnov technique was used to perform the normality test in this study, and the results of the hypothesis testing are shown in Table 3 below.

Table 3. The Normality Test of Student's Mathematical Problem Solving Ability

Research Sample Class	N	Pre-test		Post-test	
		Statistic	Sig.	Statistic	Sig.
PBL	30	,107	,200*	,109	,200*
DL	30	,117	,200*	,119	,200*

As can be observed from Table 3, the significance value exceeds the significance level (sig.) of 0.05. Specifically, the pre-test data for the DL experimental class were 0.200 > 0.05 and the pre-test data for the PBL experimental class were 0.200 > 0.05. If H 0 is accepted in this situation, it signifies that both groups' pre-test data on their capacity for problem-solving originated from a population with a normal distribution. Additionally, the PBL experimental class post-test results were 0.200 > 0.05, whereas the DL experimental class post-test data were 0.200 > 0.05. In other words, if H 0 is accepted, it means that both groups' post-test data on their propensity to solve problems are drawn from populations with regularly distributed data.

4. Homogeneity Test Data of Student's Mathematics Problem Solving Ability

Because the pre-and post-test data for the two classes are evenly distributed, the homogeneity test is performed. The homogeneity test is used to examine if two groups of sample classes have the same variance. Table 4 shows the results of the Levene test, which was used to determine homogeneity.

Table 4. The Homogeneity Test of Student's Mathematical Problem Solving Ability

Test of Homogeneity of Variances	Levene Statistic	Sig.
Pre test	,548	,462
Post-test	,035	,851

From Table 4, in the pre-test data, $F_{count} = 0.548$ was obtained while the value of $F_{table} = 4.01$. In addition, a significance value (sig.) of 0.462 is also obtained, which means it is greater than α = 0.05. This shows that the $F_{count} < F_{table}$ and value (sig.) 0.462 $>$ 0.05 then concluded that H_0 accepted, meaning that both experiment classes have homogeneous pre-test data variance. Furthermore, the post-test data obtained $F_{count} = 0.035$ while the value of $F_{table} = 4.01$. In addition, a significance value (sig.) of 0.851 is also oobtained which means it is greater than α = 0.05. This shows is that the $F_{count} < F_{table}$ and value (sig.) 0.851 $>$ 0.05 then concludes that H_0 accepted, meaning that both classes of the experiment class have homogeneous post-test data variance.

5. Statistical Analysis of Data Student's Mathematical Problem Solving Ability

Learning outcomes data will be analyzed using covariance analysis (Ancova) with the following steps.

(1) Determining the Regression Model: Regression Model: $Y = a_1 + b_1 X$ with a_1 dan $b_1$are a and b are estimates for $\theta_1$dan θ_2 of equation $Y = \theta_1 + \theta_2 X + e_1$. Based on the calculation results, the regression model of experiment class I obtained the equation of the regression model is $Y_A = 60{,}105 + 0{,}357 X_A$. And the equation of the regression model of experiment class II is $Y_B = 50{,}375 + 0{,}460 X_B$; (2) Perform an independence test: An independence test is used to determine if an independent variable has an effect on the dependent variable. Based on the findings of SPPS estimates for the mathematical problem-solving skills of students in experiment class I the value of $F_{count} = 7.316$ and $F_{table} = 4.20$. Means the value of $F_{count} > F_{table}$. In this case is H_1 accepted. This means that there is a significant influence between the results of the pre test of student's mathematics pproblem-solvingability on the student's post test in experiment class I. Furthermore, the results of the independence test for student's mathematics problem solving skills in experimental class II has value of $F_{count} =$ 5.298 and $F_{table} = 4.20$. Means the value of $F_{count} > F_{table}$. In this case is H_1 accepted. This suggests that the results of the pre-test of a student's mathematical problem-solving skills have a considerable impact on the outcomes of the post-test in experiment class II.; (3) To examine the similarity of two regression models, do a similarity test. Table 5 summarizes the findings of the computation of the similarity test and the mathematical problem-solving skill coefficient of experiment classes I and II using SPSS.

(2)

Table 5. Test Similarity of Two Regression Models Mathematical Problem Solving Ability

A	B	SSR(R)	SSTO (R)	SSE (R)	SSE(F)	F_{count}	F_{table}	H_0
57,94	0,355	541,486	3931,993	3390,45	3351,07	9,263	3,16	Rejected

The mathematics problem solving ability of the first experiment class and the second experiment class obtained $F_{count} = 9.263$ and $F_{table} = 3.16$. It means that the value $F_{count} = 9.263 > F_{table} = 3.16$. In addition, it is also obtained that the value (sig.) = 0.000 $<$ 0.05. Based on the test criteria $F_{count} > F_{table}$ and (sig.) $<$ 0.05, then H_0 was rejected. This suggests that the two linear regression models are not statistically significantly different or equivalent. (4) Run an alignment test on the two regression models if the similarity test reveals that they are not identical. based on the results of calculations using SPSS obtained $F_{count} = 0.192$ and based on Table F, for α = 0.05 obtained the value $F_{table} = 4.01$. It means $F_{count} < F_{table}$. This implies that the two linear regression models for the first and second experimental classes agree. Because the two regression models are not similar and parallel, it is possible to conclude that there are differences between the learning results of experiment class I and experiment class II. Therefore, the pre-test positively influences the ability of the post-test, or the regression of Y over X is significant.

6. Hypothesis Test

Students who are taught math using the PBL approach are thought to enhance their arithmetic problem-solving abilities more than those who are taught math using the DL technique. Concerning the statistical theory that will be investigated:

$$H_0 : \mu_1 \leq \mu_2$$
$$H_1 : \mu_1 > \mu_2$$

where:
μ_1 : average score of mathematics problem-solving ability of students that are taught by using PBL model
μ_2 : average score of mathematics problem-solving ability of students that taught by using DL model

By using the Ancova test, we obtained $F_{count} = 5.936$ and based on Table F, for α = 0.05 obtained the value of $F_{table} = 4.01$. It means $F_{count} > F_{table}$ so H_0 was rejected.

D. CONCLUSION AND SUGGESTIONS

Calculated results, conclusions, and discussion indicate that students' ability to solve mathematical problems increases more when using a problem-based learning model than when using a discovery learning approach.

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