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The Effect of Problem Based Learning Models on Students' Mathematical Problem Solving Ability and Self Efficacy

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ABSTRACT

This research aims: (1) to determine whether problem-based learning models improve mathematical problem-solving abilities and self-efficacy; (2) to explore the interaction between students' initial mathematical abilities and the learning model. The study employed a quasi-experimental quantitative design, with ANOVA used for inferential data analysis. Fifty eighth-grade students from SMP Negeri 3 Aek Kuo in the academic year 2022/2023 were examined. The null hypothesis (H0) was accepted, and the alternative hypothesis (Ha) was rejected since the significant F-test value was 0.178 > 0.05, and the T-test value was 0.692 > 0.05, indicating no significant difference in the average scores between experimental classes I and II. PBL students demonstrated better performance in answering mathematical problems compared to those in the direct learning group. Experimental class 1 achieved a mastery level of 84%, while experimental class 2 achieved a mastery level of 64%. PBL learners exhibited higher self-efficacy compared to those learning through direct instruction. Hypothesis testing indicated that students in experimental class 1 had stronger confidence in mathematical problem-solving compared to students in experimental class 2. The problem-based learning (PBL) methodology did not have a significant impact on students' mathematical problem-solving abilities. Hypothesis testing using interaction analysis yielded a significance value of 0.730 > 0.05. Both PBL and students' basic mathematical abilities influenced self-efficacy. Interaction analysis indicated a significance value of 0.000 < 0.05.

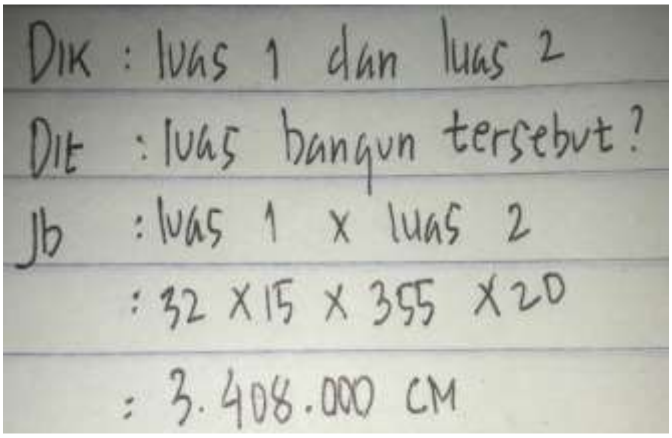
A. INTRODUCTION

According to Hasratuddin (2018), mathematics is a universal science that is the foundation for the creation of modern technology. This technology plays a vital role in a variety of fields and is an endeavor to promote human understanding. Mathematics is often referred to as "fundamental science." Students start learning mathematics in primary school in order to equip them with the capacity to think rationally, analytically, systematically, critically, and creatively as well as equip them with the ability to work together. (Darda S. and Adi S, 2013).

According to Ristanti (2017), mathematical goals are more centered on structure due to the fact that aims for numbers and space don't signify as much in mathematics as they formerly did. The relationship between these objectives and the rules that define the various stages of their execution is the most significant truth to consider. As a result of this, it may be deduced that mathematics, being a study of structure, will cover relationships, patterns, and shapes, as was discussed previously. According to Hajar, S., Bernard, H., and Djam'an (2018), the structure that is being investigated is the structure of mathematical systems. It is also possible to say that mathematics is concerned with ideas (ideas), structures, and the relationships between them. Since these elements are structured logically, mathematics is related to abstract concepts.

When it comes to finding a solution to this issue, the main character is an integral part of the process. According to Polya's definition from 1973, issue solving is an attempt to find a solution to achieve a goal that will not be easily accomplished right away. In order for students to effectively solve problems, Polya identifies four crucial steps that must first be taken, namely, a comprehension of the issue at hand, the formulation of a solution, the execution of the strategy for achieving the goal, and a final check. The study by Kamarullah (2017) on the importance of problem-solving abilities found that being able to solve problems requires higher-order cognitive capabilities including imagery, association, abstract thought, comprehensiveness, manipulation, analysis, and generalization among others. Each of these higher-order thinking skills needs rules and coordination to function properly.

As for the capital of the test questions given to determine students' problem solving abilities: "the area of the figure below is"?



Dik : luas 1 dan luas 2
Dit : luas bangun tersebut?
Jb : luas 1 x luas 2
: 32 x 15 x 355 x 20
: 3.408.000 CM

Figure 1. Student Work Sheet

It was clear from the findings of the researchers' first observations made at the school that the pupils did not comprehend the issue at hand, which meant that the issues raised by the issue could not be treated in an appropriate manner. Because students may only use what they already know to solve difficulties when implementing the technique, they are unable to draw any conclusions about the issue at hand. As a result, it is possible to draw the conclusion that the pupils of class VIII-3 at SMP Negeri 3 Aek Kuo still have very limited problem-solving ability.

In order for pupils to have an impact on their sense of self-efficacy, learning mathematics requires not only the ability to solve problems but also the development of a thought process that can lead to the formation of conclusions in the form of knowledge. According to Masri et al. (2018), self-efficacy is a belief and expectation regarding students' ability to face their tasks in the learning process. The teacher should create opportunities for students to perceive and think about the ideas given. Self-efficacy is a belief and expectation regarding students' ability to face their tasks. Numerous research point to the fact that a person's level of self-efficacy has an effect on their level of motivation, tenacity in the face of challenges, and overall learning achievement. (Simamora, R. E., Saragih, S., & Hasratuddin, 2018) Students who have a high level of self-efficacy are more likely to practice self-monitoring of their learning outcomes and use higher-quality learning strategies than students who have a low level of self-efficacy.

The findings of the survey that the researcher administered to students in classes VIII-3 at SMP Negeri 3 Aek Kuo led the researcher to the following conclusions: (1) 60% of students were unsure of their ability to finish a specific task; (2) 55% of students are unsure of their ability to motivate themselves to take the necessary actions to finish the task; (3) 65% of students are unsure of their capacity to work hard, remain persistent, and be diligent; and (4) 55% of students are unsure of their ability to survive

According to (Marlina, 2019), both the achievements and the setbacks that students have in their lives are considered to be learning experiences. This learning experience will develop students' self-efficacy in solving difficulties, which will result in an increase in the students' learning capacities. A good sense of self-efficacy is necessary in learning in order for students to fulfill their learning goals and reach their potential for achievement. Students' self-confidence in mathematics, also known as their mathematical self-efficacy, is an important component of their overall level of confidence and self-assurance. Therefore, in order for pupils to be successful in the process of learning mathematics, it is necessary for them to have a high level of self-efficacy.

Because one's sense of self-efficacy can have an effect on one's level of motivation, there is a link between it and successful academic performance. A person who has a high level of self-efficacy is someone who, when given the opportunity to learn, will express enthusiasm and work hard to showcase their ability to be successful. This is the behavior of someone who has a high level of self-efficacy. On the other side, a person who does not have a high level of self-efficacy has a tendency to avoid assignments or to carry them out half-heartedly, which increases the possibility that they would give up easily if they encountered obstacles. According to the findings shown in (Firdaus, D.M., Purwanto, S.E., and Nuriadin, 2021), it is possible to draw the conclusion that self-efficacy is a factor that contributes to mathematical competence. For this reason, it is crucial to create a lesson that not only improves students' skills in mathematical representation but also makes students feel more confident in their capacity to acquire mathematics on their own. This is because students' capabilities in mathematical representation are directly tied to their ability to understand and apply mathematical concepts.

We need a learning model that is capable of overcoming the educational challenges that have been discussed in the past in order for us to attain the goals that have been outlined above. According to Trianto (2016), the phrase "learning model" encompasses a wider scope of meaning than the terms "strategies, procedures, and methods." According to Sinaga.C.V.R. 2020, problem-based learning is a model of education that encourages students to actively participate in the learning process and to collaborate with one another. Students are required to collaborate with one another in order to complete this form of learning. It is possible for students to build their capacity for problem-solving as well as their capacity for independent study because this learning is student-centered. Problem-based learning, also known as Problem-Based Learning or PBL, is a teaching style that encourages educators to design a learning environment that starts with (related) problems that are meaningful and pertinent to students. Problem-based learning is also known as PBL, which stands for problem-based learning. In addition, students have the possibility to acquire a more realistic (actual) learning experience through the use of this method. Nova A and Fauzi, 2017).

According to Trianto (2017), a definition of the problem-based learning model can be found as follows: "The problem-based learning model (Problem Based Lerning) is a learning model that is based on many problems that require authentic investigation, specifically investigations that require real solutions to real problems." According to Widyasari, N., Dahlan, J.A., and Dewanto (2016), problem-based learning is the interaction between stimulus and response. More specifically, problem-based learning is the relationship between the two directions of learning and the environment. According to Widyasari, N., Dahlan, J.A., and Dewanto (2016), inquiry-based learning is defined as the interplay between a stimulus and a response. Students receive feedback from both the environment and the system in the form of assistance and challenges respectively. The nerves in the brain perform the role of successfully interpreting help, which enables the problems that are experienced to be selected, evaluated, analyzed, and solved in the appropriate manner.

This learning paradigm allows students to develop holistically, which means that in addition to their cognitive growth, they will also develop in the areas of affective and psychomotor growth as a natural consequence of the challenges they encounter (Setyaningsih, R., & Rahman, 2022). The PBL model draws its theoretical underpinnings from the field of cognitive psychology. The preceding explanation makes it clear that problem-based learning offers numerous chances for students to work on difficult mathematical concepts. For instance, students can work on solving problems whose resolution needs students to have a high level of self-efficacy. This can be understood in light of the explanation that has been provided.

In addition to the learning paradigm, there are other factors that have the potential to influence both the students' ability to solve mathematical problems and their sense of self-efficacy in this area. This is due to the fact that mathematics is a scientific discipline that is organized and interconnected with each of its ideas. In other words, the prior knowledge of mathematics that students already possess serves as the foundation for comprehending subsequent material. According to research done by Gustia, D., Hanifah, Jenab, and Afrilianto (2019), students whose initial mathematical ability is low or medium would have a significantly different experience than students whose KAM is high when it comes to grasping the content that is presented. In this situation, it is essential to take a close look at the interactions that take place between KAM and the enhancement of students' mathematical problem-solving abilities as well as their sense of self-efficacy in this subject area. The results of the first test are used to determine the students' initial mathematical aptitude, often known as their KAM.

SMP Negeri 3 Aek Kuo class VIII-3 pupils demonstrated low self-efficacy and limited problem-solving ability. The Problem Based Learning (PBL) methodology is ideal for developing higher-level thinking in problem-oriented scenarios. Based on this, researchers want to study "Increasing Mathematical Problem Solving Ability and Student Self-Efficacy Through the Problem Based Learning (PBL) Model".

B. RESEARCH METHODS

It was a quasi-experimental study that was conducted with the goals of determining the increase in mathematical problem-solving abilities and students' self-efficacy as a result of problem-based learning at SMP Negeri 3 Aek Kuo, as well as the determination of the interaction between early mathematical abilities and learning in the direction of increasing problem-solving abilities and students' self-efficacy in mathematics. The method of investigation that was carried out was known as quasi-experimental, and it was designed to determine these goals. The location of this study is going to be at SMP Negeri 3 Aek Kuo. The sample for this investigation came from two different classes: class VIII-3, which served as the experimental class, and class VIII-2, which served as the control class and consisted of fifty students. In terms of the outcomes of the instrument test regarding the execution of learning plans and the distribution of student workbooks.

Table 1. Instrument Validation Results

Rated aspect	Average of Each Aspect	Classification
Lesson plan	4,53	Very good
Student Worksheets	4,59	Very good

Research Design

For the sake of this particular investigation, a methodology known as a non-equivalent control group design was applied. According to Nurfatanah and Rusmono (2018), when utilizing a non-equivalent group design, the subjects are not grouped randomly, and it is frequently not viable to utilize random grouping or create new groups. In addition, when using a non-equivalent group design, it is frequently not possible to establish new groups. A pretest comes first, then multiple treatments, and finally a posttest is administered at the end of this design. Sugiyono (2018) also discussed the non-equivalent control group design, which can be observed in table 2.

Table 2. Non-equivalent Control Group Design

Class	Pretes	Treatment	Postes
Experiment	0_1	X_1	0_2
Control	0_3	X_2	0_4

C. RESULT AND DISCUSSION

This research is a research that is being undertaken with the objective of seeing and knowing how the effect of the Problem Based Learning model has on the capacities of students to solve mathematical problems as well as the self efficacy of students. Both a control group and an experimental group were used in the research that the researchers conducted. After interviewing students from classes VIII-2 and VIII-3 at SMP Negeri 3 Aek Kuo for a period of three weeks in order to collect the necessary data for the research project.

As a consequence of this research, we were able to collect the results of the initial math ability tests, the results of the math problem solving ability tests, and the results of the self-efficacy questionnaire scores of students from both the experimental class and the control class. These data were achieved by splitting the students into two groups: the experimental class and the control class. Other data, such as the results of the students' initial reading ability exams, the results of the reading ability tests, and the results of the reading ability tests, were also collected. These results are included in the data set.

Inferential Statistical Analysis of Mathematical Problem Solving Ability.

The results of the normality test that was carried out with SPSS version 21 on the outcomes of the mathematical problem solving ability tests (KPM) that were given to students are presented in the table that can be seen below.:

Table 3. Normality Test Results for Mathematical Problem Solving Ability

Tests of Normality

	Class	Kolmogorov-Smirnov		
		Statistic	Df	Sig.
Learning outcomes	Pretest Experimental Class I	.140	25	.200*
	Posttest Experimental class II	.161	25	.092
	Pretest Experimental Class I	.203	25	.091
	Posttest Experimental class II	.247	25	.060

As can be seen from Table 3, all of the data for Both the experimental class I, which utilized the problem-based learning paradigm, and the experimental class II, which utilized direct learning, demonstrate that the Kolmogorov Smimov significance value is present. This is something that can be seen when comparing the findings from the pre-test to the results from the post-test. The significant value in the pre-test for the experimental class I, which makes use of the problem-based learning model, was determined to be 0.200, which was higher than 0.05. This indicated that the value was statistically significant. The score on the posttest for experimental class I, which employs the problem-based learning paradigm, is 0.092, which is greater than 0.05. This indicates that the paradigm of problem-based learning was successfully implemented. The experimental class II pretest produced a score that was 0.091 points higher than 0.05 when analyzed through the lens of the direct learning model. In addition, with regard to the exploratory class II posttest, we found that adopting the direct learning model yielded a score that was 0.060 higher than 0.05. Therefore, based on the decision making premise of the normality test, it is possible to draw the conclusion that these data have a normal distribution, which indicates that H0 is accepted, and testing for homogeneity can now be continued.

If it turns out that H0 is rejected in the homogeneity test, which would imply that Ha is legitimate, the subsequent action is to use an alternative method, more precisely the Mann Whitney U Test, as the following step in the process. If the results of the homogeneity test demonstrate that H0 is not valid, then this is the conclusion that must be drawn. Table 1 presents the outcomes of the homogeneity test of the students' mathematical problem-solving ability tests and the findings of the students' self-efficacy questionnaires, both of which were performed with SPSS version 21. The tests were administered to the students.

Table 4. Homogeneity Test Results Student Mathematical Problem Solving Ability Test

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	.959	3	96	.416
	Based on Median	.928	3	96	.430
	Based on Median and with adjusted df	.928	3	90.948	.430
	Based on trimmed mean	.988	3	96	.402

In light of the findings that were shown in table 4, it is possible to deduce that the significant value calculated based on the mean is 0.416, which is greater than 0.05. Therefore, the hypothesis H0, whereas the data variance in the control class is deemed to be homogeneous, the hypothesis that says that there is no difference in variance across the data groups can be regarded valid for the experimental class when utilizing the problem-based learning paradigm. thus allows the hypothesis to be considered valid for the experimental class.

Self Efficacy Inferential Statistical Analysis

Before beginning the analysis of the research data, the normality test was performed initially in order to determine whether or not the data obtained from the self-efficacy questionnaire came from a population that was normally distributed. This test for normalcy makes use of the Kolmogorov Smirnov test, which is conducted with the SPSS software. The Kolmogorov-Smirnov test is a component of the traditional assumption test, the purpose of which is to ascertain whether or not the values of the residuals follow a normal distribution.

The following table presents the findings obtained from the application of SPSS version 21 to the calculation of a normalcy test on the results of a self-efficacy questionnaire.:

Table 5. Results of the Normality Self Efficacy Test

Class		Kolmogorov-Smirnov[a]		
		Statistic	Df	Sig.
Self Efficacy	Experiment class I	.106	25	.200*
	Experimental class II	.241	25	.110

You can see the outcomes of the computation of the normality test with Kolmogoro Smimov mentioned in Table 5. The significance value for experimental class I was greater than 0.05. To be more specific, 0.200 is a bigger number than 0.05, which shows that the experiment was a success. Additionally, the significance value of the experimental class II was found to be greater than 0.05; more specifically, 0.110 was shown to be greater than 0.05. Therefore, based on the basis of decision making rather than the normality test, it can be concluded that the data obtained from the student self-efficacy questionnaire, which totaled 50 people and had 12 questions, is normally distributed, which states that H0 is accepted and can be continued with a homogeneity test. This can be done because the decision making basis is based on the basis of decision making rather than the basis of the normality test. This conclusion is attainable due to the fact that it is feasible to make conclusions not on the basis of the normalcy test but rather on the basis of decision making.

Table 6 Student Self-efficacy Homogeneity Test Results

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
Self Efficacy	1.628	1	48	.208

In light of the findings that were presented in Table 6 earlier, it is possible to draw the conclusion that the significant value of self-efficacy is 0.208 more than 0.05. In order for the hypothesis H0, It asserts that there is no discernible variation in variance across the data groups, in order for it to be approved and for it to have a data variance that is consistent throughout.

DISCUSSION

Mathematical problem solving is the capacity to solve issues that are not routine or that can be addressed quickly with procedures, strategies, and qualities that students follow so as to discover the proper solution. This ability is also known as the skill of finding solutions to situations that need quick attention and resolution. This study's objective was to evaluate and contrast the level of mathematical problem-solving skills exhibited by students who were instructed in two separate classrooms using either a problem-based learning model or a conventional learning model. These classes were known as the experimental class (because they were instructed using problem-based learning), and the control class (because they were instructed using conventional learning models). The study made use of the data that was gained from the results of the assessments of students' mathematical problem-solving abilities with circle material. The data was gathered from the tests that were administered. For their problem-solving ability, students in the experimental class that was taught utilizing the problem-based learning technique obtained a score of 14.858, with a significance value of 0.001 0.05. Therefore, it is possible to say that problem-based learning has an effect on the abilities of students to answer multiple mathematical problems concurrently. This implies that Hypothesis 0 (H0) should not be accepted, but that Hypothesis 1 (H1) should be accepted.

Self-efficacy can be described as people's beliefs about their ability to generate preset levels of performance that have an influence on events that occur in their lives, as stated by Sari, D.P., Syahputra, E., and Surya (2018). Self-efficacy is defined as people's views about their ability to generate predefined levels of performance. When a person believes that they are capable of achieving particular levels of performance, they are said to have self-efficacy in that area. People's perspectives on their own levels of self-efficacy have a significant role in determining not only their emotions, ideas, and behaviors, but also the things that drive them. After the students in both the experimental class and the control class have acquired knowledge through the problem-based learning model and the traditional learning models, the next step is to determine how much self-efficacy the students in both classes have by administering self-efficacy questionnaires to as many as 50 students in each class. This will allow for a more accurate assessment of the students' levels of confidence in their abilities. An accurate evaluation of the pupils' degrees of self-efficacy will be made possible as a result of this. The students in both the experimental class and the control class had their levels of self-efficacy assessed, and the results showed that both sets of students had levels that were equal to 5.216, with a significance value of 0.007 0.05. As a result, it is reasonable to assert that learning through problem-solving has an affect, simultaneously, on the self-efficacy of students, which indicates that Hypothesis 0 should be rejected and Hypothesis 1 should be accepted.

D. CONCLUSION AND SUGGESTIONS

Problem-based learning (PBL) students solve math problems better than direct learners. Students' talents vary. Hypothesis testing and learning completeness calculations from posttest scores showed that students' learning completeness in experimental class I was 84% and in experimental class II was 64%. Hypothesis testing and learning completeness estimations from posttest scores proved this. PBL students exhibit stronger self-efficacy than direct learners. Both classes have different abilities. The hypothesis testing showed that experimental class I students had greater confidence in solving mathematical problems than experimental class II students. Hypothesis testing proved this. It's not that problem-based learning (PBL) models don't affect students' arithmetic skills. Testing the hypothesis with a significant value score greater than 0.05 proves this.

Thus, the problem-based learning (PBL) methodology does not affect students' arithmetic problem-solving abilities based on their basic math skills. The previous explanation concludes that early mathematical abilities and problem based learning (PBL) models do not interact on mathematical problem solving abilities. Students' math self-efficacy depends on their basic mathematical skills and the problem-based learning (PBL) approach. Testing the hypothesis yielded a significant value score of 0.000 0.05, proving the argument. Thus, H0 is false and H1 is true, proving that the problem-based learning (PBL) paradigm and students' initial mathematical skills affect self-efficacy.

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