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IMPROVING MATHEMATICAL PROBLEM SOLVING SKILLS AND SELF-CONFIDENCE OF JUNIOR HIGH SCHOOL STUDENTS USING A PROBLEM-BASED LEARNING

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ABSTRACT

Problem solving ability is one of the skills that need to be developed in students. The background of this study is based on the results of preliminary observations which show that students' problem solving skills and self confidence are still low, one of which is caused by the use of conventional learning methods. This study aims to determine the effect of problem-based learning on improving students' mathematical problem solving ability and self-confidence, see the effectiveness of problem-based learning on students' mathematical problem solving ability and self-confidence and see students' responses to problem-based learning. This research used quasi-experimental method with Pretest-Posttest Control Group Design. The research subjects were VIII grade students of SMP Negeri 2 Saguling as many as 64 students, consisting of two classes, namely experimental and control. The research instrument was a description test to measure mathematical problem solving ability and a Likert scale to measure students' self-confidence. Data were analyzed using normality test, homogeneity, t-test, Mann-Whitney, and N-Gain calculation. The results showed that there was a significant difference between the experimental and control classes in improving mathematical problem solving skills seen from the average n-gain value of the experimental class in the high category while the control class was in the medium category. Problem based learning is very effective in improving mathematical problem solving skills seen from the percentage of student learning completeness and effective in increasing student self confidence. Students' response to problem-based learning was positive.

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INTRODUCTION

Problem solving skills are very important for students. Learning experts agree that problem-solving skills can be developed through the subject areas and disciplines taught. Problem is a word that is often heard by us. But something becomes a problem depending on how someone gets the problem according to his ability. A problem is a conflict, an obstacle for students in

completing their learning tasks in class. However, problems must be solved so that students' thinking processes continue to develop.

Problem solving is a process to overcome the difficulties faced to achieve the expected goals. In mathematics, problem solving skills must be possessed by students to solve problem-based problems. Polya (Jainuri, 2014) defines problem solving as an attempt to find a way out of a difficulty in order to achieve a goal that cannot be achieved immediately. According to Sumarmo (Sumartini, 2016) problem solving is a process to overcome the difficulties faced to achieve a desired goal. Branca (Sumarmo, 1994) said that problem solving can be interpreted using a general interpretation, namely problem solving as a goal, problem solving as a process, and problem solving as a basic skill.

Students' mathematical problem solving skills are also important to develop. The importance of problem solving is stated by Branca (Effendi, 2012), he argues that problem solving ability is the heart of mathematics. This is in line with NCTM (Lette & Manoy, 2019) which states that problem solving is an integral part of mathematics learning, so it should not be separated from mathematics learning. Ruseffendi (Siahaan & Surya, 2020) argued that problem solving skills are very important in mathematics, not only for those who will later study or study mathematics, but also for those who will apply it in other fields of study and in everyday life. Problem solving ability is one of the skills that need to be developed in students. This is in line with the opinion of Lasmita (2019) which states that one of the goals of learning mathematics is to train students' problem solving skills.

Based on the opinions of the experts above, it can be concluded that solving ability is an ability that is considered important for students to have, to face a world that continues to change is an ability that can be used to help students make decisions for themselves, as well as for their environment. The ability that can help students to make decisions is mathematical problem solving ability. Mathematical problem solving ability is a high-level mental process and requires a more complex thinking process. Where by learning problem solving in the learning process, it will allow students to think more critically in investigating problems, thus making students better at responding to and solving a problem. Then students can apply this mathematical problem solving ability in solving problems in mathematics learning, other learning, and in solving problems in everyday life.

In addition to problem solving ability as a cognitive aspect of students, self-confidence is also very important for students. Self confidence is a sense of self that is usually used as self-assurance in one's personal judgment, ability, strength. Self-confidence is believing in one's ability to achieve some goals. Yates (Hendriana et al., 2017) explains the importance of self-confidence for students, where according to him, student success in learning mathematics is influenced by the level of student confidence. With self-confidence, students will like learning math more and be more motivated, so it is hoped that students' math learning achievement will be more optimal.

Based on observations, problem solving skills and student confidence at SMPN 2 Saguling are still relatively low. This is shown from observations made in class VIII which numbered 30 students. Of these students, only 8 students were able to understand the problem and solve the problem while the others could not solve the problem and their self-confidence was very low. The low problem solving ability of students and students' self-confidence is due to several factors. First, the learning methods used by teachers are still conventional. Second, due to the students themselves who do not care about learning math and lack confidence in solving math problems. So far, mathematics learning seems to have not touched on the substance of problem solving (Chen et al., 2019). Students tend to memorize mathematical concepts, so students' problem-solving skills are lacking (Verschaffel et al., 2020), (Damianti & Afriansyah, 2022).

Mathematics is considered boring and less interesting by most students so that students do not understand the meaning and concepts of the material being taught. For this reason, an appropriate solution is needed to overcome this problem so that it is expected to improve mathematical problem solving skills and build students' self-confidence.

To improve students' mathematical problem solving ability and self-confidence, it needs to be supported by the right learning method. One of the learning methods to improve problem solving ability is problem-based learning. According to Arends (Budiarti, 2021), Problem Based Learning (PBL) is a learning approach where learners work on authentic problems with the intention of compiling their own knowledge, developing inquiry and higher-level thinking skills, developing independence and self-confidence. In line with Bern and Erickson (Taofiq et al., 2018) emphasized that problem-based learning is a learning strategy that involves students in solving problems by integrating various concepts and skills from various disciplines.

The Problem Based Learning model has advantages that are different from other models. The following advantages are explained according to Barret (E. K. Dewi & Jatiningsih, 2015) including: (1) Students are encouraged to have the ability to solve a problem in a real situation. (2) Students are expected to have the ability to build their own knowledge through learning activities. (3) Learning focuses on problems so that unrelated material does not need to be learned by students at that time. (4) There is a scientific activity in students through group work. (5) The sources of knowledge commonly used by students can be obtained from libraries, the internet, interviews and observations. (6) Students have the ability to assess their own learning progress. (7) Students have the ability to carry out scientific communication in the implementation of discussions or presentations of the results of their work. (8) Individual student learning difficulties can be overcome through group work in the form of peer teaching.

METHOD

The method used in this research is a quasi-experiment with a design in the form of pretest-posttest Control Group Design, which is a design that involves two groups, 1) Experiment, which uses Problem Based Learning (PBL) learning model; and 2) Control, which uses the usual learning model (conventional). Each group is given different treatment, but before and after learning, both groups are given the same pretest and posttest to measure changes in the dependent variable, namely mathematical problem solving ability and self-confidence. According to Russeffendi (2010) the research design is described as follows in figure 1:

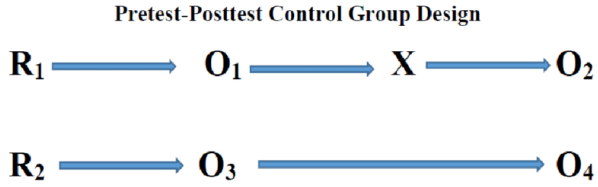

Figure 1. Pretest-Posttest Control Group Design

Description:

R_n : Sampling is done randomly by class

O_n : Pre-response instrument and Post-response instrument

X : Problem-based learning

The population in this study were all VIII grade students of SMPN 2 Saguling. Sampling was done by randomized class (cluster random sampling), with the following results, 1) 32 students of Class VIII-A as the experimental class (using PBL model); and 2) 32 students of Class VIII-B as the control class (using conventional learning). The independent variable is the problem-

based learning model and the dependent variable is students' mathematical problem solving ability and self-confidence. The research instrument is a mathematical problem solving test instrument consisting of 5 description questions related to SPLDV material. The questions were developed based on indicators: 1). Understand the problem; 2). Designing a mathematical model; 3). Solving the model; 4). Checking the correctness of the solution. Each item was given a maximum score of 10, with a total maximum score of 50.

The validity, reliability, distinguishing power, and difficulty index tests were conducted on class IX at Nurussa'adah Islamic Junior High School and the results are presented in Table 1 below:

Table 1. Recapitulation of Analysis Results of Each Item of Mathematical Problem Solving Ability Test Instruments

Question No	Validity		Reliability		DP		IK		Interpretation
	Score	Criteria	Score	Criteria	Score	Criteria	Score	Criteria	
1	0,84	High	0,89	Very Hig	0,33	Simply	0,69	Medium	Used
2	0,73	High			0,36	Simply	0,67	Medium	Used
3	0,88	High			0,42	Good	0,69	Medium	Used
4	0,89	High			0,48	Good	0,70	Medium	Used
5	0,87	High			0,46	Good	0,70	Medium	Used

The Self Confidence scale uses a 4-point Likert with 34 statements (17 positive, 17 negative) that refer to the indicators: 1). Confidence in self-ability; 2). Independence in making decisions; 3). Positive self-concept; 4). Courage to express opinions. The highest score for each statement is 4 and the lowest is 1. This scale has been tested for validity and reliability, and all items are declared valid. This research was carried out in three stages: namely: preparation stage, implementation stage, evaluation & data analysis stage.

1. Preparation Stage
   a. Literature study
   b. Preparation of instruments and learning devices
   c. Instrument testing
   d. Initial data collection (pretest)
2. Implementation Stage
   a. Implementation of the PBL model in the experimental class according to the syntax:
      1) Orientation to the problem
      2) Student organization
      3) Independent/group investigation
      4) Development and presentation of results
      5) Analysis and evaluation of problem solving results
   b. The control class was given conventional learning
   c. Final data collection (posttest)
3. Evaluation and Data Analysis Stage

a. Data processing using SPSS
b. Descriptive and inferential statistical analysis
c. Drawing conclusions

Data analysis techniques include: 1). Normality Test (Shapiro-Wilk); 2). Homogeneity Test (Levene's Test); 3). Two Mean Difference Test; 4). T-test for normally distributed and homogeneous data; 5). Mann-Whitney test for abnormal data.

RESULTS AND DISCUSSION

Results

The mathematical problem solving ability, self-confidence of students using problem-based learning model and ordinary learning are attached in Table 2. Based on Table 2, in the pretest, it was found that there was no difference in students' mathematical problem solving ability between the two learning approaches, and the scores were at a very low level (19.76% and 19.62% of the ideal score). Nevertheles, after the learning process, on mathematical problem solving ability and its gain (N<G>) and on self-confidence, students treated with the problem-based learning approach achieved better scores (75.76% of the ideal score, N<G> 0.704 and 67.13% of the ideal score) compared to the scores of students taught with conventional learning (44.38% of the ideal score, N<G> 0.307 and 56.18% of the ideal score).

Table 2. Mathematical Problem Solving Ability and Self Confidence of Students in Problem Based Learning and Regular Learning

	Problem Based Learning n=32					Conventional Learning n=32				
	Pretest		Posttest		Gain	Pretest		Posttest		Gain
	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Mathematical Problem Solving	9,88	19,76	37,88	75,76	0,704 (High)	9,81	19,62	22,19	44,38	0,307 (Medium)
Std. Dev	3,17		9,54		0,22	2,89		2,89		0,06
Self Confidence			91,3	67,13				76,4	56,18	
Std. Dev			8,44					5,39		

Description: Ideal Maximum Score (SMI) Mathematical Problem Solving Ability = 50

Ideal Maximum Score (SMI) Self Confidence = 136

The results showed that the Problem Based Learning (PBL) model had a significant effect on improving students' mathematical problem solving ability and self-confidence. This improvement is shown through the analysis of posttest and n-gain scores which are higher in the experimental class than the control class, as well as significant statistical test results <0.05 on both variables.

The data description of the research results is as follows:

1. Mathematical Problem Solving Ability

a. Data Analysis Pretest of Mathematical Problem Solving Ability

Pretest was conducted at the beginning of learning to determine the initial ability of students. First, a normality test was carried out on the pretest data to see whether the data was normally distributed or not, based on the results of the pretest normality test, the

significant value for the experimental class was 0.122 and for the control class was 0.164. Because the significant value> 0.05, it is accepted, it can be concluded that the pretest data is declared normally distributed. Furthermore, the homogeneity test is carried out to determine whether the variance of the two groups is homogeneous or not, based on the results of the homogeneity test, a significant value> 0.05 is obtained, namely 0.658 which means it is accepted, so it can be concluded that the two variances are homogeneous. Therefore, it can be continued to test the difference between the two averages of the two classes using the T-test. The T-test aims to determine whether there is a difference in the average of the two classes on mathematical problem solving ability between the experimental class and the control class. Based on the results of the T-test, it is found that the sig value (2-tailed)> 0.05, namely 0.935, which can be concluded that it is accepted, so it can be said that there is no significant difference in students' mathematical problem solving ability between the experimental class and the control class. This means that the initial abilities of the two classes are the same.

b. Data Analysis Posttest of Mathematical Problem Solving Ability

The post-test was conducted after learning to determine the ability of students after being given treatment. First, a normality test was carried out on the post-test data to see whether the data was normally distributed or not. Based on the results of the post-test data normality test, it was found that the significant value for the experimental class was 0.000 and for the control class was 0.030. Because the significant value <0.05, it is rejected. It can be concluded that the post-test data is not normally distributed. Furthermore, a non-parametric test of mathematical problem solving ability will be carried out using the Mann-Whitney test. The Mann-Whitney test aims to determine whether there is a significant difference between the two classes in mathematical problem solving ability between the experimental and control classes. Based on the results of the Mann-Whitney test, it is found that the asymp sig (2-tailed) value <0.05, namely 0.00, which can be concluded that it is rejected, so it can be said that there is a significant difference in students' mathematical problem solving ability between the experimental and control classes. Therefore, the mathematical problem solving ability of students who use the problem-based learning model is better than those who use ordinary learning.

c. Data Analysis N-Gain of Mathematical Problem Solving Ability

The n-gain score is used to see the improvement of students' mathematical problem solving ability obtained from the difference between the pretest and posttest scores with the ideal maximum score of students' mathematical problem solving ability. The average pretest and posttest scores of mathematical problem solving ability are presented in Table 3 below:

Table 3. Average Score of Mathematical Problem Solving Ability

Class	Average Pretest	Average Posttest	Category
Experiment	9,88	37,88	High
Control	9,81	22,19	Medium

The average score of the experimental class pretest was 9.88 and the average posttest was 37.88. The average score of the control class pretest was 9.81 and the average posttest was 22.19. The ideal maximum score in this research assessment is 50.

The average n-gain of mathematical problem solving ability in the experimental class and control class is presented in Table 4 below:

Table 4. Average N-Gain Value of Mathematical Problem Solving Ability

Class	Average N-Gain	Category
Experiment	0,704	High
Control	0,307	Medium

Judging from the average N-gain results, the problem-based learning model provides a higher improvement than ordinary learning.

2. Self Confidence

Self confidence data was obtained through the results of a non-test self confidence scale given to students in class. The test consists of 34 statements related to student self-confidence with a weighted score of 1 to 4. Data collection on students' self-confidence was obtained using a non-test instrument in the form of a scale given to the experimental class and control class. To determine students' self-confidence after treatment, students were given several statements in the form of scales in the experimental class and control class, the data from this scale were analyzed to determine the difference in self-confidence in the two classes that had different treatments. First, the normality test of self confidence data is carried out, based on the results of the normality test, it is found that the significant value for the experimental class self confidence data is 0.074 and the control class has a significant value of 0.666 Because the significant value of the experimental class and control class> 0.05, it is accepted, meaning that the data from both soft skill values are normally distributed. Furthermore, the homogeneity test of Self Confidence data on the achievement of problem solving skills is carried out to determine whether some population variances are the same or not. Based on the results of the homogeneity test, it is found that the significant value> 0.05 is 0.226 which means it is accepted, so it can be concluded that the two variances are homogeneous. After the data is known to be normally distributed and homogeneous, the next test is the difference between the two means of self confidence data using the t-test. This aims to determine whether there is a difference in the average of the two classes on self-confidence between the experimental class and the control class. Based on the results of the t-test, it is found that the sig value (2-tailed) <0.05, namely 0.00, which can be concluded that it is rejected, so it can be said that there is a significant difference in students' self-confidence between the experimental and control classes. The average score of the self confidence scale in both classes is presented in Table 5 below:

Table 5. Average Self Confidence Scale Score

Class	Average Pos-response	Category
Experiment	91,3	High
Control	76,4	Medium

From Table 5 above, it can be concluded that learning using the problem-based learning model is better than ordinary learning.

Improvement of dominant indicators in the experimental class:

1) Confident in solving problems independently
2) Dare to convey ideas in group discussions
3) Having a positive view of mistakes as part of learning

3. Learning Effectiveness Test

The effectiveness of the problem-based learning model is calculated based on the percentage of students who achieve a score ≥ Minimum Completeness Criteria (KKM).

Table 6. Percentage of Student Learning Completeness

KKM (70)	Many Students (n=32)		Percentage of Completion
	Completed	Not Complete	
Pretest	0	32	0%
Posttest	25	7	78,13%

Based on Table 5, it can be seen that at the time of the pretest the students' mathematical problem solving ability was not complete, then after being given problem-based learning as treatment, at the time of the posttest the students' mathematical problem solving ability reached a percentage of completeness of 78.13%, it was concluded that the problem-based learning model was very effective in improving mathematical problem solving ability.

Furthermore, the effectiveness of the Problem Based Learning learning model, seen from the number of student self confidence scale scores in the experimental class which reached a score of 2,923 from the Ideal Maximum Score (SMI) 4352. By using the effectiveness test formula, it is obtained:

$$E = \frac{f}{n} \times 100\% = \frac{2923}{4352} \times 100\% = 67{,}16\%$$

Based on the above calculations, the percentage of the total self confidence scale score against the SMI is 67.16%, it can be concluded that the problem-based learning model is effective in building student self confidence.

4. Student Response to Learning

Students' response to mathematics learning using problem-based learning model on the material of two-variable linear equation system. The results of this response were obtained at the end of learning. The results of student responses to problem-based learning in the experimental class of 32 respondents are presented in Figure 2 below:

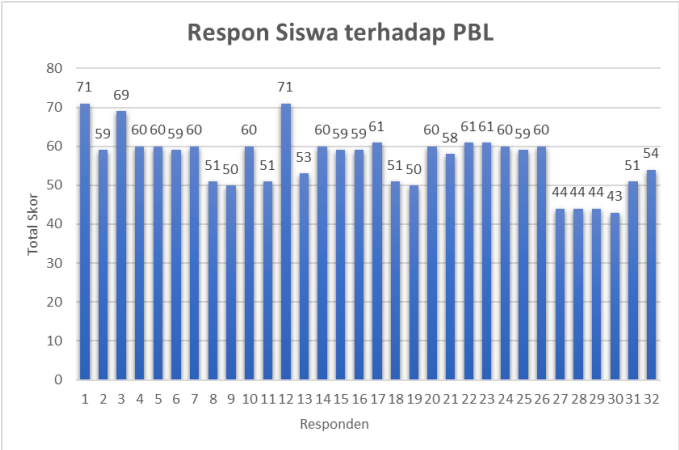

Figure 2. Results of Student Response to Problem Based Learning

The percentage of students' response to problem-based learning is presented in Figure 3 below:

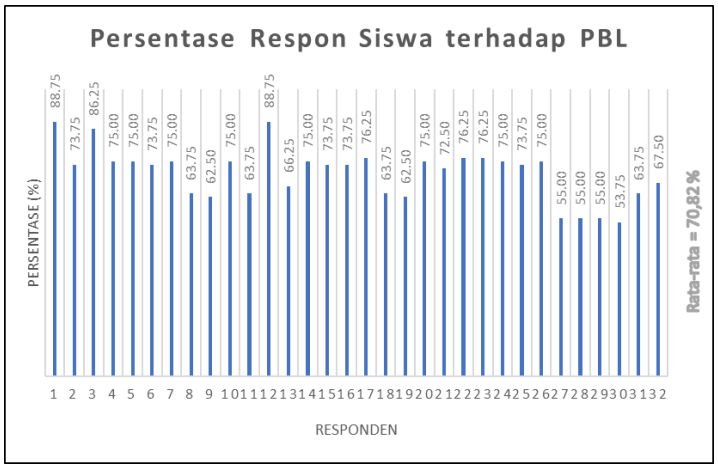

Figure 3. Percentage of Student Response to PBL

From Figure 2, it can be seen that the average percentage of student responses to problem-based learning is 70.82%, it can be concluded that student responses to problem-based learning received a positive response.

Discussions

Improving students' mathematical problem solving skills needs to be supported by appropriate learning methods so that learning objectives can be achieved. Problem Based Learning is a learning approach that emphasizes the presentation of real problems as a learning stimulus. In this model, students are actively involved to understand the problem, design a solution strategy, and evaluate the solution while ordinary or conventional learning focuses more on the active role of the teacher in delivering material through lectures, while students tend to be passive. Interaction is limited and the exercises provided are often mechanistic. This leads to a lack of opportunities for students to develop higher order thinking skills, including mathematical problem solving ability independently. PBL has the main advantage of facilitating analytical and creative thinking processes. By placing students as active subjects of learning, they are invited to think systematically, accustomed to developing problem-solving strategies. PBL also encourages collaboration in groups, which strengthens social aspects and mathematical communication. The strategies applied in the implementation of PBL in this study include: selection of appropriate contextual problems, formation of heterogeneous learning groups, and active guidance from the teacher as a facilitator. The process of group discussion, presentation of results, and joint reflection strengthened concept mastery and mathematical problem-solving skills. The main challenges in implementing PBL include: time constraints, teacher readiness, and students' diverse initial abilities. The solutions taken include the preparation of a flexible learning schedule, gradual habituation to the PBL model, and providing training to teachers to improve competence in implementing problem-based learning effectively. The results of this study showed that the experimental class that used the PBL model experienced a higher increase in mathematical problem solving ability compared to the control class that used ordinary learning. The statistical test results (t-test and Mann-Whitney) proved that the difference was significant. These findings are similar to several studies (Utami et al., 2023); (Ramadhani et al., 2024); (Ma'wa et al., 2021); (Hikmah, 2023); (Azura et al., 2024) on the mathematical problem solving ability of students who use problem-based learning better than students who use ordinary or conventional learning.

Self Confidence is a person's belief in his or her ability to face and solve challenges, and express opinions openly. According to Spencer (Rais, 2022), self confidence includes feelings of confidence, independence and responsibility in social interactions and academic activities. In

the context of learning mathematics, self-confidence is very important because it can affect students' motivation and active participation in the learning process. Ordinary learning often makes students passive, only listening to the teacher's explanation without the opportunity to convey ideas or participate actively. As a result, students tend to lack confidence because they are not used to expressing their opinions or solving problems independently. This situation is inversely proportional to the learning environment that fosters self-confidence. The PBL model provides space for students to work in groups, convey ideas, discuss, present the results of group work. This process encourages students to be more confident because they feel their opinions are valued and have a contribution to problem solving. With active involvement and success in solving problems, students' self-confidence increases. The implementation of PBL in increasing self-confidence is done by encouraging cooperative group work, providing space for students to express their opinions, and familiarizing self-reflection on the learning process. The teacher acts as a facilitator who provides positive feedback and motivates students to dare to perform and actively contribute. Challenges faced in improving self-confidence through PBL include students' shyness and fear of being wrong, as well as the dominance of some group members. Solutions include creating a psychologically safe environment, dividing group tasks fairly and involving all students in discussions. In addition, teachers need to familiarize students to dare to try, even if they make mistakes. In this study, students in the experimental class showed a more significant increase in self-confidence compared to the control class. The results of self confidence scale analysis and statistical tests reinforce this finding. Previous research also supports this, as stated by Hendriana et al., (2017), that PBL can increase students' self-confidence because it is participatory and builds positive learning experiences. Similar findings on self-confidence, several studies (Safitri et al., 2023); (Wondo & Meke, 2021), with problem-based learning, and other studies (Hendriana, 2009); (Hendriana, 2014) and (Tamsil, 2015) using innovative learning approaches reported that students had quite good self-confidence.

The effectiveness of the problem-based learning model seen from the percentage of student learning completeness concluded that problem-based learning is very effective in improving mathematical problem solving skills. This finding is in line with previous research by (Wulandari & Damris, 2011); (Sianturi et al., 2018), which states that PBL is effective in improving mathematical problem solving skills. In addition, the problem-based learning model seen from the average score of students' self-confidence scale concluded that problem-based learning is effective in increasing students' self-confidence. This finding is in line with research (Syaifatunnisa et al., 2015); (Rudiya et al., 2019) and (Fardani et al., 2021), which say that the PBL model is effective in increasing student confidence.

The application of the PBL model not only had an impact on student learning outcomes, but also gained positive responses from students. Students' responses showed that they felt more motivated, active, and confident in participating in the learning process. Learning that emphasizes collaboration, discussion, and problem solving makes students more interested and feel they have an enjoyable learning experience. Thus, positive responses from students reinforce the finding that PBL not only improves students' cognitive and affective aspects, but also creates a more active, participatory and meaningful learning environment. This finding is in line with (Ekapti, 2016); (A. M. P. Dewi et al., 2020); (Kusuma & Candramila, 2017) and (Imelda & Anzelina, 2019) reported that students' responses to the learning-based learning model also received positive responses.

CONCLUSION

Based on the results of the thesis research entitled Improving Mathematical Problem Solving Ability and Self Confidence of Junior High School Students Using Problem Based Learning Model, it can be concluded as follows:

1. Improvement of Mathematical Problem Solving Ability of Students Using Problem Based Learning is Better than Ordinary Learning. Judging from the N-Gain value for the experimental class is 0.704 which is in the high category and the control class is 0.307 which is in the medium category.
2. Self Confidence of Students Using Problem Based Learning is Better than Ordinary Learning. Judging from the average student self confidence scale in the experimental class is 91.3 and the control class is 76.4.
3. Effectiveness of Problem Based Learning in Improving Problem Solving Ability and Self Confidence in Mathematics Learning of Junior High School Students. Judging from the results of the effectiveness test of the experimental class, in the post-test score there is a percentage of completeness of 78.13% which is included in the criteria very effective.
4. Student responses to Problem Based Learning get an average percentage of 70.82%, it can be concluded that student responses to problem-based learning get a positive response.

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