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# Improved Mathematical Problem Solving Ability And Student Learning Independence Through Problem Based Learning In SMA Negeri 8 Padangsidimpuan

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***Abstract:*** *The purpose of this research is to know: (1) Is the problem solving ability of mathematical students who get problem based learning better than student who get ordinary learning. (2) Whether the learning independence of students who acquired problem-based learning is better than that of students who received regular learning. (3) Interaction between learning and early math ability to students' mathematical problem solving abilities. (4) Interaction between learning and math early ability to student learning independence. (5) Improving students' mathematical problem solving ability after obtaining problem based learning. (6) Increasing students' self-reliance after obtaining problem based learning. This type of research is a quasi experiment. The population of this study is all students of SMA Negeri 8 Padangsidimpuan. Then randomly selected two classes totaling 56 people. The experimental class is subject to problem-based learning and the control class is treated with ordinary learning. The instruments used consist of: (1) test of mathematical problem solving ability, (2) questionnaire of student learning independence. The instrument is said to have fulfilled the terms of content validity, as well as reliability coefficients of 0.97 and 0.89 respectively for mathematical problem solving ability and learning independence. Data analysis was performed by two-lane T and ANAVA test analysis. The result of the research shows that (1) the problem solving ability of mathematical students who get problem based learning is better than the students who get the usual learning. (2) learning independence of students who acquired problem-based learning is better than students who received regular learning. (3) There is no interaction between the learning model and the early mathematical ability of students' mathematical problem solving abilities. (4) There is no interaction between the learning model and the early mathematical ability of the students' learning independence. (5) Improved mathematical problem solving ability of students who were given problem-based learning with N-Gain average of 0.54 was moderate. (6) Increasing students' self-reliance with problem-based learning with N-Gain average of 0.52 is moderate.*

***Keywords:*** *Problem-based learning, mathematical problem-solving skills, learning independence*

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## I. Introduction

One of the government's efforts to educate the nation's life is through education. Therefore, education must be able to develop the potential of students to be ac tive, creative, and competitive human beings so as to be able to face the ever-changing age situation. The government has implemented a number of subjects that must be studied. One of them is mathematics.

Mathematics is one of the areas of study that occupy an important role in education. As stated in the standard contents for elementary and secondary education units of mathematics (1) it has been mentioned that the subjects of mathematics need to be given to all learners ranging from primary schools to equip learners with logical, analytical, systematic , Critical, and creative, and the ability to work together.

In line with the above statement, the National Council of Teachers of Mathematics (2) also formulated that the objectives of mathematics subjects are: learning to communicate (mathematical communication), learning to reason (mathematical reasoning), learning to solve problems (mathematical problem solving ), Learning to associate ideas (mathematical connections), and learning for representation (mathematical representation).

Based on the above objectives it can be concluded that learners must have the ability to understand mathematical concepts, using reasoning on patterns and traits, can solve problems related to ideas and have an attitude of appreciating the usefulness of mathematics in life.

Based on the analysis of the 2012 PISA (Program for International Student Assessment) results that measured literacy, math and science skills of 15 year old students in SMP / MTs / SMA / MA / SMK, Indonesia

is second only to Peru. Of the 494 average international scores, Indonesian students only earn an average of 375. These results indicate Indonesian students' mathematical abilities are still below international standards (3).

One of the doing maths that is closely related to the characteristics of mathematics is the problem-solving ability. In solving the problem there is certainly a problem to be solved. A problem is called a mathematical problem if mathematical procedures such as arithmetic and algebraic procedures are needed to solve them. Troubleshooting is a process used to solve a problem. Hudojo (4) argues that problem solving is a very essential thing in learning mathematics in school, because students become skilled in selecting relevant information, then analyzing it and finally examining the results.

In fact, the desire to develop students' problem-solving abilities in schools is still not up to expectations. This is shown from the results of observations in SMA Negeri 8 Padangsidimpuan show that students still find it difficult in understanding and solving problems designed to develop the ability of thinking process. From the results of mathematical problem-solving test test given by the researchers to 28 students, the average score obtained by the students is 40.63 then it is proved that the problem solving ability of mathematical students of SMA N 8 Padangsidimpuan is still less category.

In addition to problem-solving skills, other research focus is one of the affective aspects of learning independence. Learning independence is the readiness of students who are willing and able to learn by showing their own initiative, with or without the help of others in terms of determining learning objectives, learning methods, and evaluation of learning outcomes.

The importance of students' self-reliance is not yet compatible with the facts seen in the field. From the result of the questionnaire, it can be concluded that 65% of students do not have the learning initiative yet, 55% of students have not been able to diagnose their learning needs, 65% of students have not been able to manage and control their learning, 60% of students have not been able to utilize and search for relevant sources, and 65% Students have not been able to choose and apply the learning strategy.

Other factors can also contribute to students 'mathematical abilities and to students' mathematical learning attitudes, namely the early math ability (KAM) of students, students who are classified into high, medium and low groups. The early ability of mathematics is a prerequisite that must be possessed by students in order to follow the lesson smoothly. This is due to the structured subject matter so that students with high initial ability can follow the lesson on the next material. Students who have medium or low KAM take time to receive new knowledge in the learning process.

Lack of level of problem solving ability of mathematics and student learning independence, not apart from and how teachers teach and student's interest and response to mathematics itself. From the results of the interview the researchers did to one of the students in SMA N 8 Padangsidimpuan through discussions outside the classroom, it is known that the math lesson is the most difficult lesson in solving problems related to everyday life. Students give the reasons that the problems teachers teach are not the same while studying in the classroom so that students become confused and cause laziness and are not motivated to learn mathematics.

This happens because the learning process is still conventional, where the teacher usually deliver the material in the package book, providing information, understanding, concepts directly to students, giving examples of application of mathematical formulas, doing exercises that have not related to the facts real ( Contextual learning). This is in accordance with the proposed by Trianto (5) namely:

The main problem in formal education (school) today is still low absorption of learners. This is evident from the average learning outcomes of students who are always still very alarming. This achievement is certainly the result of learning conditions that are still conventional and not touch the realm of the learner's dimension itself, that is how to actually learn it. In a more substantial sense, that the current learning process still provides teacher dominance and does not provide access for students to develop independently through discovery in the process of thinking.

The same thing is also said by Trianto (6) that empirically, based on the results of research analysis of low learning outcomes of learners caused by the dominance of conventional learning process. In this learning the classroom atmosphere tends to be teacher-centered so that students become passive. In this case, students are not taught learning strategies that can understand how to learn, think, and motivate themselves, but these aspects are the key to success in a lesson.

Based on the above phenomenon, teachers should be required to find ways that can nurture student learning motivation. One way is to offer a problem-based learning. By using problem-based learning, students can find their own concepts taught so that they can use and remember longer concepts. Arends (7) argues that the essence of problem-based learning in the form of presenting a variety of problematic situations that are authentic and meaningful for students who can serve as a springboard for investigation and investigation. In other words problem-based learning is a learning approach in which students work on authentic issues with the intent to build their own knowledge, develop inquiry and high-level thinking skills, develop independence, and self-confidence (8).

Application of the PBM model can help students become autonomous and independent learners. With recurrent teacher guidance, learning with the PBM model can encourage and direct students to ask questions, solve their own tasks in learning, and solve problems students find in everyday life independently (9). Independent learning gives students the freedom to discover how academic life fits into their daily lives. Students make their own decisions and are responsible for the matters caused by the decision. Students also organize and adjust their actions to achieve desired goals (10)

Several studies related to problem-based learning have been studied by Ibrahim (11), this research shows that the improvement of problem solving abilities of mathematical students whose learning using problem-based learning is better than students whose learning using conventional learning.

Nasution's research (12), concluded that the results of data analysis of the average pretest score performed on the group of students who received learning through PBM with an average of 18.86 and groups of students who received learning only through direct learning with an average of 14.59. From the result of pretest score test of both groups it can be concluded that both groups have the same initial ability or no significant difference. Based on the above description, it can be understood that problem-based learning provides many opportunities for students to do complex maths as examples in solving problems whose solutions require that students have learning independence.

## II. Method

This type of research is quasi experiment. The population of this research is all students of SMA Negeri 8 Padangsidimpuan. The sample in this study, randomly selected two classes of six classes. The two classes that are drawn are X-1 and X-2 which respectively to determine the experimental class and control class. In this study selected X-2 class as experiment class and X-1 class as control class. The experimental class is subject to problem-based learning and the control class is treated with ordinary learning. The instruments used consist of: (1) test of mathematical problem solving ability, (2) questionnaire of student learning independence. The instrument is said to have fulfilled the terms of content validity, as well as reliability coefficients of 0.97 and 0.89 respectively for mathematical problem solving ability and learning independence. Data analysis was performed by two-lane T and ANAVA test analysis.

## III. Result and Discussion

**Result**

The students' mathematical problem solving skills were obtained from the pretest results in the experimental and postes classes in the experimental and control classes. Based on the pretest results given before the learning in the experimental class, then done the average calculation and standard deviation test results of students' mathematical problem solving skills. The test results of students' mathematical problem solving ability can be seen in Table 1 below.

**Table 1** Results of Pretest Ability of Mathematical Problem Solving for Experimental Classes

| Statistic | Learning |
|---|---|
| | Experiment class |
| | Pretes |
| $\sum$ | 1590 |
| $\bar{X}$ | 56,79 |
| SD | 8,96 |

After given treatment, then students are given postes. Based on postes result given after learning to both class, that is experiment class for problem based learning and control class for ordinary learning, then do mean calculation and standard deviation test result of problem solving ability of student mathematical problem. The test results of students' mathematical problem solving ability can be seen in Table 2 below.

**Table 2** Results Postes Ability of Mathematical Problem Solving for Class of Experiment and Class of Control

| Statistic | Learning | |
|---|---|---|
| | Experiment Class | Control Class |
| | Postes | Postes |
| $\sum$ | 2270 | 2058 |
| $\bar{X}$ | 81,07 | 73,48 |
| SD | 6,03 | 7,33 |

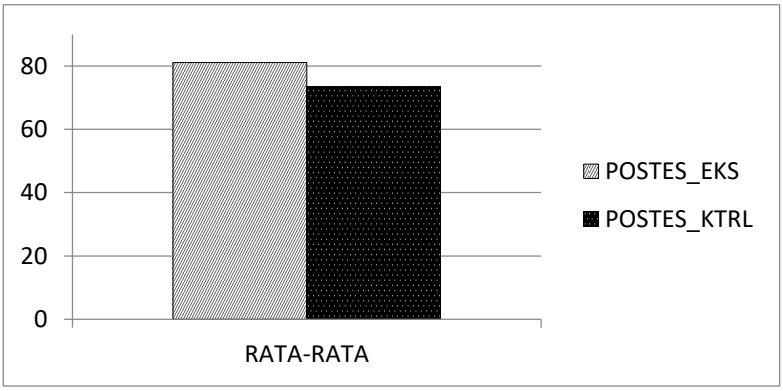


**Figure 1** Graph of Average Postes Ability of Mathematical Problem Solving for Class of Experiment and Class

Based on the graph above shows that for the ability of solving the problem of mathematical average postes for all students of experiment class is 81,07, while control group that is 73,48, hence from that data experiment class have better mathematical problem solving ability from control class. The average increase of mathematical problem solving test results obtained from pretest and postes for experimental classes given problem-based learning can be seen in Table 3.

**Table 3** Results of Pretest and Postes Ability of Mathematical Problem Solving for Experimental Classes

| Statistik | Learning | |
|---|---|---|
| | Experiment Class | Experiment Class |
| | **Pretes** | **Postes** |
| **Σ** | 1590 | 2270 |
| $\bar{X}$ | 56,79 | 81,07 |
| **SD** | 8,96 | 6,03 |

Table 3 shows an increase in the students' mathematical problem-solving test results in the experimental class where the postes average is higher than the pretest average of 81.07> 56.79. This indicates that there is an increase in the average of mathematical problem solving test results in the experimental class of 24.28.

Improved test results of students' mathematical problem solving skills can also be seen based on indicators on mathematical problem solving abilities. The test results of students' mathematical problem solving abilities based on indicators can be seen in Table 4.

**Table 4** Pretest and Postes Results Mathematical Problem Solving Ability Based on Indicators

| Indicator | Group Learning | Average | |
|---|---|---|---|
| | | Pretes | Postes |
| Identify the elements that are known and asked | Experiment | 11,86 | 12 |
| | Control | | 12 |
| Identify the elements that are known and asked | Experiment | 6,57 | 10,79 |
| | control | | 9,46 |
| Identify the elements that are known and asked | Experiment | 4,29 | 9,61 |
| | Control | | 7,96 |

Table 4 shows an average increase in students' mathematical problem-solving abilities after the learning of the experimental class. Pretest averages, experimental class postes and control class postes for the first indicator of 11.86; 12 and 12, the second indicator is 6.57; 10.79 and 9.46, the third indicator is 4.29; 9.61 and 7.96. Furthermore, the improvement of pretest and postes result of the mathematical problem solving ability of the experimental class and control class postes can be seen in the graph presented in Figure 2

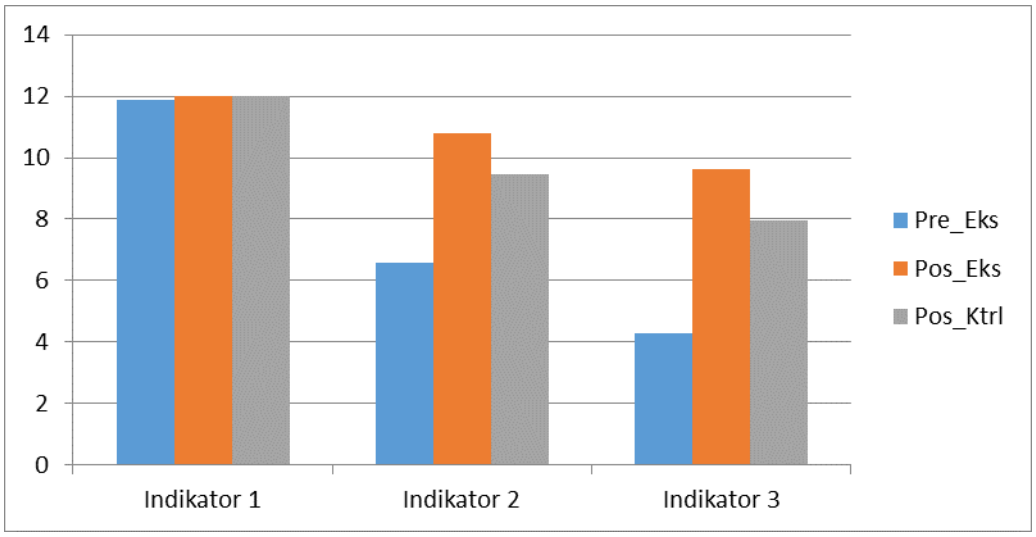


**Figure 2** Average Graph of Pretes and Postes Class Mathematical Problem Solving Abilities Experiment and Postes Control Class

Figure 2 shows an increase in the problem solving ability of the experimental class mathematics students based on each indicator. The average first postes indicator is higher than the pretest average of 12> 11.86. This means that there is an average increase in students' mathematical problem solving abilities for the first indicator of 0.14. So also for the second indicator average postes higher than the average pretes that is 10.79> 6.57. This means that there is an average increase in students' mathematical problem solving abilities for a second indicator of 4.22. Likewise for the average postes of the third indicator is higher than the pretes of 9.61> 4.29. There is an increase in the average of students' mathematical problem solving abilities for the third indicator of 5.32.

Based on the above description, it can be seen that the average increase in problem solving ability of mathematical students of experimental class of each indicator has increased and the biggest increase is in third indicator. This suggests that there is a better impact on students who are given problem-based learning.

## IV. Discussion

Based on the average score obtained clearly visible ability of problem solving mathematical students who get problem based learning (PBM) better than students who get regular learning, the average result of mathematical problem solving ability can be seen more clearly using SPSS program 23.00 as follows:

**Table 5** Average Postes Score Mathematical Problem Solving Ability for Student Class Experiments And Control

| **Group Statistics** | | | | | |
|---|---|---|---|---|---|
| | KELOMPOK | N | Mean | Std. Deviation | Std. Error Mean |
| POSTES | EKS | 28 | 81.07 | 6.029 | 1.173 |
| | KTRL | 28 | 73.48 | 7.329 | 1.412 |

**Tabel 6** Analisis Kemampuan Pemecahan Masalah Matematis Siswa dengan Uji T

| **Independent Samples Test** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | F | Sig. | T | Df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| POSTES | Equal variances assumed | .442 | .509 | 4.183 | 54 | .000 | 7.679 | 1.836 | 3.998 | 11.359 |
| | Equal variances not assumed | | | 4.183 | 52.250 | .000 | 7.679 | 1.836 | 3.995 | 11.362 |

Furthermore, based on postes result of problem solving ability mathematically obtained by student, will be analyzed learning interaction and early ability of mathematics (KAM) student to student problem solving ability of mathematics. The students' early math skills are grouped into three categories: students with high,

moderate and low math skills. Hypothesis testing that has been formulated is analyzed using Analysis of Two Path Variance using statistic F with formulas and criteria specified. The results of hypothesis test analysis analysis with the help of SPSS 23.00 program can be seen in Table 7.

**Table 7.** Learning Interaction Test Results and Early Mathematical Ability to Ability Mathematical Troubleshooting

| Tests of Between-Subjects Effects | | | | | |
|---|---|---|---|---|---|
| Dependent Variable: POSTES | | | | | |
| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
| Corrected Model | 1748.863[a] | 5 | 349.773 | 10.539 | .000 |
| Intercept | 304277.381 | 1 | 304277.381 | 9168.565 | .000 |
| KAM | 939.166 | 2 | 469.583 | 14.150 | .000 |
| PEMBELAJARAN | 790.638 | 1 | 790.638 | 23.824 | .000 |
| KAM * PEMBELAJARAN | 13.818 | 2 | 6.909 | .208 | .813 |
| Error | 1659.351 | 50 | 33.187 | | |
| Total | 338210.000 | 56 | | | |
| Corrected Total | 3408.214 | 55 | | | |
| a. R Squared = .513 (Adjusted R Squared = .464) | | | | | |

Based on Table 7, it can be seen that the interaction between the learning factor and the initial ability of mathematics (KAM) obtained the value of Fcount = 0.208 with significance level of 0.813 and the value of Ftabel = 3.38. This means Fhitung <Ftabel .. This means there is no mutual influence given by the learning and KAM of the students to the ability of problem solving mathematically, this is in line with research of Delina (2015). In addition there is no interaction of learning and the ability of early mathematics students to improve the ability of mathematical problem solving can also be seen on the graph that can be seen in Figure 3 below:

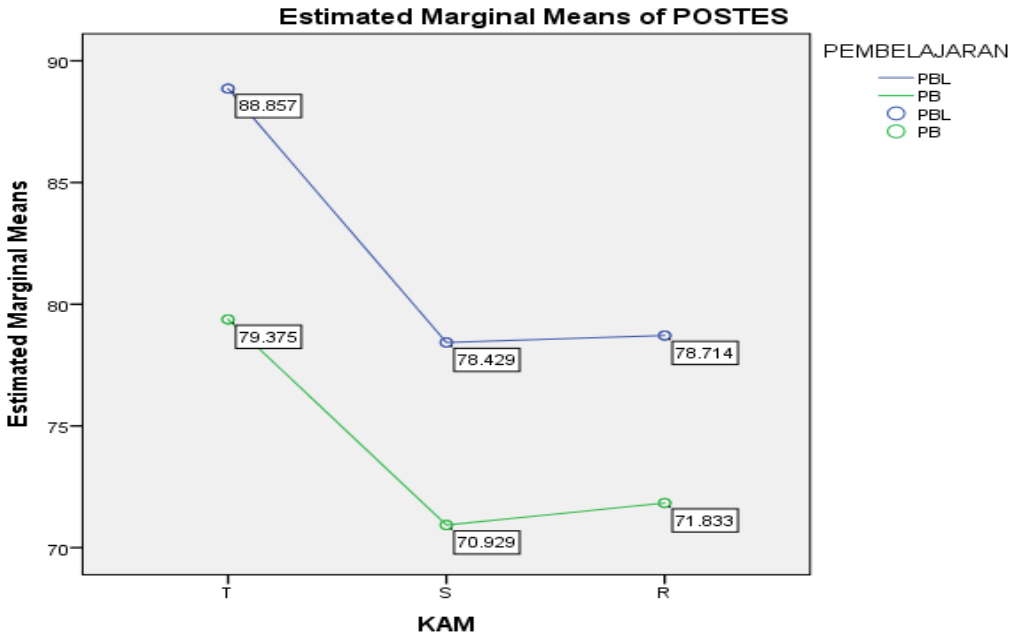


**Figure 3.** Interaction between Learning Factors and Students KAM against Resolving Ability Mathematical Problems

**Results Angket Independence Student Learning**

Student learning independence is obtained from pretest results in the experimental class and postes in the experimental class and control class. Based on the pretest results given before the learning in the

experimental class, then done the calculation of average and standard deviation result of questionnaire student self-reliance. The results of the questionnaire student self-reliance can be seen in Table 8 below:

**Table 8** Results of Pretest Questionnaire Independence of Student Learning Experiment Class

| Statistic | Learning |
|---|---|
| | Experiment Class |
| | Pretes |
| $\sum$ | 1721 |
| $\overline{X}$ | 61,48 |
| SD | 5,70 |

Based on postes result given after learning to second class, that is experiment class for problem based learning and control class for ordinary learning, then do mean calculation and standard deviation result of questionnaire student self reliance. The result of questionnaire student learning independence can be seen in Table 9 below

**Table 9** Results Postes Independence Learning Experiment Class and Control Class

| Statistic | Learning | |
|---|---|---|
| | Experiment Class | Control Class |
| | Postes | Postes |
| $\sum$ | 2280 | 2043 |
| $\overline{X}$ | 81,44 | 72,96 |
| SD | 6,58 | 5,99 |

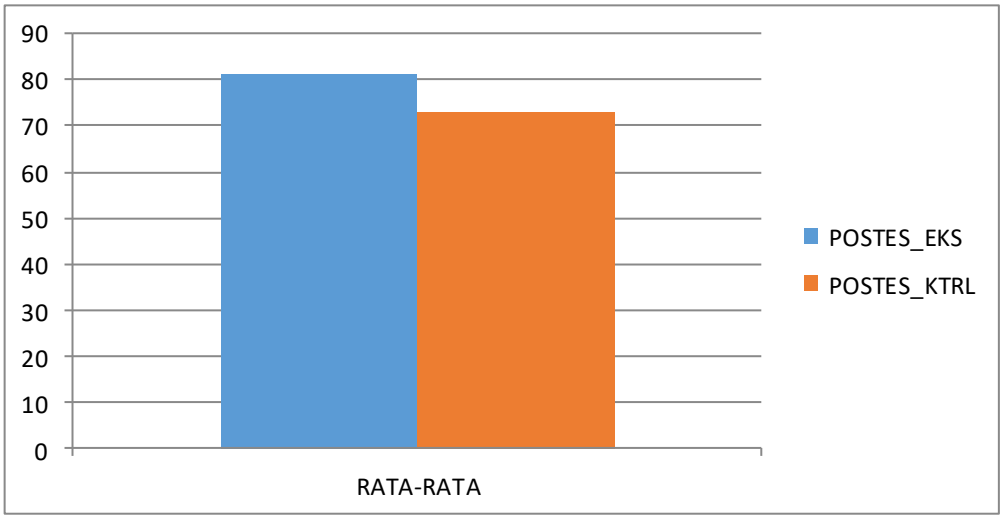


**Figure 4.** Average Graph of Postes Independence Learning Experiment Class and Control Class

Based on the graph above shows that for the average learning independence postes for all students of experiment class is 81,44, while control group that is 72,96, hence from that data experiment class have independence learn better from control class. The average increase of learning independence questionnaire results obtained from the pretest and postes for the experimental class given problem-based learning can be seen in the following Table 10:

**Table 10** Pretest and Postes Results Independence Learning Experimental Class

| Statistic | Learning | |
|---|---|---|
| | Experiment Class | Experiment Class |
| | Pretes | Postes |
| $\sum$ | 1721 | 2280 |
| $\overline{X}$ | 61,48 | 81,44 |
| SD | 5,70 | 6,58 |

The table above shows an increase in the questionnaire results of students' learning independence in the experimental class where the average postes result is higher than the pretest average is 81,44> 61,48. This indicates that there is an average increase of questionnaire result of student's learning independence in

experimental class of 19,96. The improvement of student self-reliance questionnaire results can also be seen based on indicators on students' self-reliance. The questionnaire results of student self-reliance based on indicators can be seen in Table 11.

**Table 11.** Pretest and Postes Results Independence Based Learning Indicators

| Indicator | Indicator | Average | |
|---|---|---|---|
| | | Pretes | Postes |
| Learning initiative | Learning initiative | 10,75 | 13,11 |
| | | | 12,39 |
| Diagnose needs in learning | Diagnose needs in learning | 11,75 | 13,54 |
| | | | 13,11 |
| Organize and control the progress of learning | Organize and control the progress of learning | 11,93 | 13,36 |
| | | | 12,21 |
| Regulate and control cognition, motivation and behavior in learning | Regulate and control cognition, motivation and behavior in learning | 12,36 | 13,79 |
| | | | 11,79 |
| Choose and explain learning strategies | Choose and explain learning strategies | 13,29 | 13,57 |
| | | | 11,93 |
| Viewing adversity as a challenge | Viewing adversity as a challenge | 12,86 | 13,18 |
| | | | 11,43 |
| Evaluate the learning process and outcomes | Evaluate the learning process and outcomes | 10,46 | 10,68 |
| | Indicator | | 8,86 |

Table 11 shows an increase in the average of student learning independence after the teaching of the experimental class. Pretest averages, experimental class postes and control class postes for the first indicator of 10.75; 13.11 and 12.39, the second indicator is 11.75; 13.54 and 13.11, the third indicator is 11.93; 13.36 and 11.79, the fourth indicator is 12.36; 13.79 and 11.79, the fifth indicator is 13.29; 13.57 and 11.93. The sixth indicator is 12,86; 13.18 and 11.43, while the seventh indicator is 10.46; 10.68 and 8.86. Furthermore, the improvement of pretest and postes result of students' independence of experimental class and control class postes can be viewed on the graph presented in Figure 5.

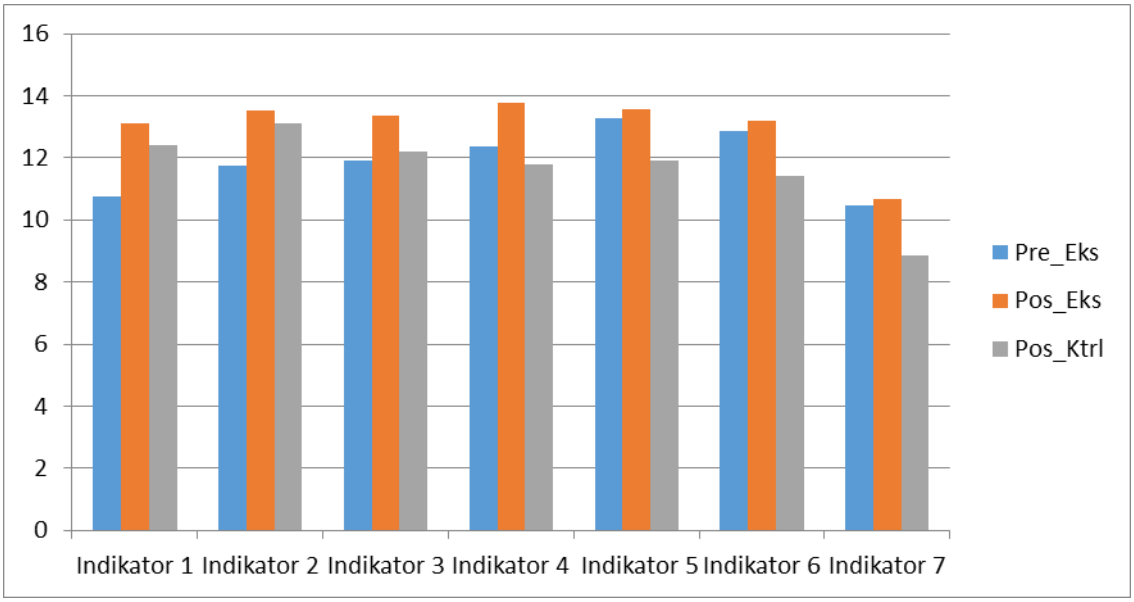


**Figure 5** Average Graph of Pretes and Postes Independence Classroom Learning Experiments and Postes Classes Control

Figure 5 shows an increase in student learning independence of experimental class based on each indicator. The average first postes indicator is higher than the pretest average of 13.11> 10.75. This means there is an increase in the average of student learning independence for the first indicator of 2.36. For the second indicator the postes average is higher than the pretest average of 13.54> 11.75. This means there is an increase

in average student learning independence for the second indicator of 1.79. For the third indicator the postes average is higher than the pretest average of 13.36> 11.93. This means there is an increase in average student learning independence for the third indicator of 1.43. For the fourth indicator the postes average is higher than the pretest average of 13.79> 12.36. This means there is an increase in average student learning independence for the fourth indicator of 1.43. For the fifth indicator the postes average is higher than the pretest average of 13.57> 13.29. This means there is an increase in average student learning independence for the fifth indicator of 0.28. So also for the sixth indicator average postes higher than the average pretest ie 13.18> 12.86. This means there is an increase in average student learning independence for the fifth indicator of 0.32. Likewise for the average postes of the seventh indicator is higher than the pretest of 10.68> 10.46. There is an increase in the average of students' mathematical problem solving abilities for the third indicator of 0.22.

Based on the above description, it can be seen that the average increase in student learning independence of experimental class each indicator has increased and the biggest increase is in the first indicator. This suggests that there is a better impact on students who are given problem-based learning.

**Limitations of Research**

Implementation of a research is expected to obtain an optimal result. But a study, not apart from the limitations that can not be avoided. For that, the researchers will describe it in the hope of opening opportunities for other researchers who want to conduct similar research that is useful for the expansion of science education, among others:

1. This research is only done within ± 1 month. Because the time of this study is very limited of course will greatly affect the results of research that has not been maximized. Instead, the meeting plus to get a better result.
2. At the time of group discussion, there are still students who depend on other students who are considered more capable. In this case the teacher directs the students to participate more actively in the learning in order to solve the problems given.
3. Allocation of learning time is widely used for group discussions, so the issues discussed become less. For mnegatasinya teachers can provide a variety of questions in each group, then each group to present the results of answers in front of the class, so that the whole group can understand the form of a variety of questions.
4. In the process of LAS, there are some groups who have difficulty in understanding the steps of LAS workmanship. In this case, teachers can give more attention to groups that often experience obstacles.
5. When presenting the work of the group in front of the class, there are still groups who are not daring and afraid to present it. To overcome this teacher gives direction and motivation to be brave and more confident in presenting result of group discussion.
6. Limitations of research that cause rejection of alternative hypothesis caused by some things that is relatively short research time, and the limitations of tools at the time of learning activities. In addition, because the simple random sample selection used in this study allows the spread of uncontrolled variables to be uneven in the selection of each experimental group.

## V. Conclusion

Based on data analysis of research results and discussions that have been described in this study, obtained some findings that the achievement of research objectives that have been determined. This research is related to the implementation of problem-based learning and ordinary learning to improve the ability of mathematical problem solving and independence of students studying SMA Negeri 8 Padangsidimpuan. As for some conclusions obtained, namely:

1. Mathematical problem-solving skills of students who acquire problem-based learning is better than those with ordinary learning. Students taught with problem-based learning received posttest average of 81.07 mathematical problem solving abilities, while students taught with ordinary learning earned an average postes of mathematical problem solving abilities of 73.48.
2. Student independence of students who acquired problem-based learning better than students who received regular learning. Students taught with problem-based learning earn an average postes of learning independence of 81.44, while students taught with ordinary learning earn an average postes of learning independence of 72.96.
3. There is no interaction between learning model with the students' early (mathematics) ability (high, medium, low) to the ability of mathematical problem solving. Thus, no contribution is contributed simultaneously by the learning model with the student's early mathematical ability to the mathematical problem-solving abilities. However, improved mathematical problem-solving skills are better than ordinary learning models for high, moderate and low students' early abilities.
4. There is no interaction between learning model with the students 'early (mathematics) ability (high,

medium, low) to students' self-reliance. Thus, no contribution is contributed simultaneously by the learning model with the students 'early math skills to students' learning independence. However, the increase in student self-sufficiency is better compared to the usual learning model for high student initial ability, moderate and low.

5. Improved mathematical problem-solving abilities of students who were given problem-based learning with an average N-Gain of 0.54 were moderate.
6. Increasing the independence of students who are given problem-based learning with average N-Gain 0.52 is moderate.

**Implications**

This research focuses on improving the problem solving ability of mathematics and student's learning independence through problem based learning at SMA Negeri 8 Padangsidimpuan students. Therefore some of the implications of this research are as follows:

1. Problem-based learning can be applied to improve students' mathematical problem solving skills.
2. Problem-based learning can be applied to improve students' learning independence.
3. Problem-based learning can be applied to increase student activity in mathematics learning to become more active

**Suggestion**

Based on the conclusion of the results of this study, then following some suggestions that need to get attention from all parties concerned about the use of problem-based learning in the process of learning mathematics. The suggestions are as follows:

1. To the teacher
   a. The application of mathematics learning through problem-based learning should serve as an alternative of learning in SMA in an effort to develop problem solving ability of mathematics and student learning independence especially in trigonometric material. Therefore, this learning approach should be developed in the field that makes the students trained in solving problems. Likewise, in improving the independence of learning, students become trained to become more independent students in preparing themselves to face the lessons in the class or future.
   b. Learning tools produced can be used as a comparison for teachers in developing learning tools of mathematics through problem-based learning on trigonometric material.
   c. Considering that this problem-based learning can improve the ability of mathematical problem solving and student learning independence so as to provide a positive response to learning that usually uses only one instruction for all students and a basic grouping of students in learning. So the application of problem-based learning can give more opportunity to the students themselves in learning and cooperating with friends who have the same difference

2. To the relevant Institution
   a. Problem-based learning with emphasis on problem solving abilities and student learning independence is still foreign both for teachers and students, therefore need to be socialized by schools or related institutions in the hope of improving students' mathematics learning outcomes, in particular improving the problem solving ability of mathematics and student learning independence.
   b. B. Problem-based learning can be used as an alternative in improving problem solving skills and students' learning independence on trigonometric material so that it can be used as input for schools to be developed as an effective learning approach to other mathematical material.

3. To the next researcher
   a. The application of problem-based learning in this study emphasizes the ability to solve mathematical problems and student learning independence and is limited to trigonometric material. So further research is needed on other mathematical materials and abilities so that the implications of the research results can be applied in schools. The application of problem-based learning in this study is limited to one level of education ie SMA, so it is expected that further research can take research population in other education level.

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