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Improvement of Mathematical Problem Solving Ability of High School Students through Problem Based Learning

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ABSTRACT

The ability to solve mathematical problems is a very important part that must be owned and developed by students in learning mathematics. However, generally Indonesian students' abilities are very low in understanding complex information and problem solving. Therefore, this article aims to know: 1) the increase in Mathematical Problem Solving Ability (MPSA) of students who get Problem Based Learning (PBL) better than students who get conventional learning with a scientific approach is reviewed overall and based on KAM levels; 2) find out the interaction between PBL and conventional models with KAM level to MPSA; 3) the difference in MPSA increase of students who get PBL learning in terms of KAM level. The research method used was a quasi-experimental research design with a pretest-posttest control group design. The sample of 6 grade students of SMAN 2 Bangkinang Kota class XI totaling 183 students. The instrument in this article is a MPSA test using t-test, two-way ANOVA test and one-way ANOVA test. The results in this study were: 1) the increase in MPSA of students who received PBL learning was better than students who received conventional learning in terms of overall and KAM; 2) there is a significant interaction between PBL and conventional models with KAM level to MPSA; and 3) there is a difference in the increase in MPSA of students who get PBL learning in terms of KAM level significantly.

1. Introduction

In the 2013 curriculum it was stated that the purpose of learning mathematics, so that students; 1) understand mathematical concepts, explain the interrelationships between concepts and apply concepts or algorithms flexibly, accurately, efficiently, and precisely in problem solving, 2) use reasoning on patterns and

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properties, carry out mathematical manipulations in making generalizations, compiling evidence, or explaining ideas and mathematical statements, 3) solving problems, 4) communicating ideas with symbols, tables, diagrams, or other media to clarify the situation or problem, 5) having an attitude of appreciating the usefulness of mathematics in life, an attitude of curiosity, attention, and interest in learning mathematics, and tenacity and confidence in problem solving (Latif & Akib, 2016).

Based on the third objective of learning mathematics, it can be seen that Mathematical Problem Solving Ability (MPSA) is a very important part that must be owned and developed by students in learning mathematics. The importance of MPSA is owned by students, stated Branca (in Reski, et al., 2019), that MPSA is a general goal of mathematics learning, even as the heart of mathematics, MPSA includes methods, procedures, and strategies; MPSA is the core and main process in the mathematics curriculum; and MPSA is a basic ability in learning mathematics.

The learning process that can provide opportunities for students to be able to solve problems still does not get an adequate portion. Various findings in the field indicate the weaknesses in the implementation of mathematics learning because the teacher is less prepared for students to learn on their own. Among these findings are (1) mathematics learning is limited to providing stock to students to be able to solve test questions. The questions given are in the form of objective tests, where students tend to learn mathematics by memorizing sample problems or learning questions that have already been solved or the answer key; (2) mathematics learning is separate from everyday experience; and (3) mathematics teachers teach with conventional learning.

Such learning processes have an impact on student MPSA. Related to this, based on the results of the PISA survey in 2015 (OECD, 2016), Indonesia ranked 63 out of 72 participating countries with an average score of 386 for mathematics with an average international score of 490. Factors that contributed to the low achievement of Indonesian students in PISA were weak ability to solve non-routine or high level problems. The questions tested in PISA consist of 6 levels (lowest level 1 to highest level 6). While students in Indonesia are only accustomed to routine questions at levels 1 and 2. Therefore, it can be concluded that the ability to solve mathematical problems of Indonesian students is low (Inayah, 2018).

In developing student MPSA, teachers need to build a learning process that facilitates students playing an active role in mastering subject matter. Wahyudin in Sumartini (2016) said that one important aspect of planning rests on the ability of teachers to anticipate the needs and materials or models that can help students to achieve learning goals. Also supported by Sagala in Luritawaty (2018) that teachers must have a method of learning as a strategy that can facilitate students to master the knowledge provided. In addition, teachers must know the difficulties experienced by students in learning mathematics so that appropriate solutions can be given so that learning objectives can be achieved.

One effort to improve the learning process that can improve student MPSA is problem based learning (PBL) learning. According to Abdurrozak, Jayadinata, `atun (2016) understands PBL is learning that emphasizes the help of problems in daily life that students must solve through independent investigations to work towards improving quality in solving problems so that and the essential concepts of learning. Nafiah and Suyanto (2014) also discussed PBL as learning using real-world problems as participants to learn about critical thinking and problem-solving skills, and to obtain essential knowledge and concepts from subject matter. Furthermore, Shofiyah and Wulandari (2018) said that PBL is a learning model that initiates students by presenting a problem that can be handled by students. During the problem-solving process, students build knowledge and develop solving skills and independent learning skills. Based on some above understanding it can be concluded PBL is a learning that directs students to think and solve a problem of interaction with their environment. PBL learning helps students develop thinking skills, solve problems, and intellectual skills, learn about various adult roles through simulations, and become independent learners. In addition to the learning factor, there are other factors that can affect students 'mathematical abilities, namely the students' initial ability towards mathematics. As Prajitno & Mulyantini (2008) states that the ability of students to learn new ideas depends on their prior knowledge and cognitive structures that already exist. Early knowledge-oriented learning will have an impact on the process and the acquisition of adequate learning.

In accordance with the problems stated above, the objectives to be achieved in this study are to find out: 1) the improvement of MPSA for students who receive PBL is better than students who receive conventional learning in terms of overall and KAM level (high, medium, and low); 2) There is an interaction between PBL and conventional models with KAM level to MPSA; and 3) there is a difference in the increase in MPSA students who get PBL learning in terms of KAM level.

2. Methodology

This research is a quasi-experimental research design with pre-test - post-test control group design. With the following research designs:

$$\begin{array}{cccc} R & O_1 & X & O_2 \\ R & O_3 & & O_4 \end{array}$$

Figure 1. Research Design

The experimental class got the PBL learning application treatment and the control class got the conventional learning application treatment.

The population in this study were all high school students in Kab. Kampar. The sample of the study was determined based on the purposive sampling technique, namely class XI students from medium high school level in the selected Kampar district, namely SMAN 2 Bangkinang Kota, the researcher took six classes, then

the researcher randomly determined three classes that received PBL learning and three classes that got conventional learning with a scientific approach. The research sample of 183 students, consisting of 91 experimental class students and 92 control class students. The division of the sample group is based on the Mathematical Preliminary Ability (KAM) from the results of the Final Semester I mathematics grade XI grade students of SMA Negeri 2 Bangkinang Kota in the 2018/2019 Academic Year, then a class average and standard deviation can be determined so that students with high KAM levels can be grouped experiment 17 people and the control group 18 people, KAM level while the experimental group 63 people and the control group as much as 63 people, while the low level KAM the experimental group 11 people and the control group also as many as 11 people. Furthermore, the two groups of classes performed a Mathematical Problem Solving Ability Test before treatment (pre-test) and after treatment (post-test).

The data in this study are quantitative data obtained through analysis of students' answers on MPSA tests conducted before (pre-test) and after (post-test) student learning activities in the experimental class and the control class. To collect MPSA data, a written test technique is used in the form of MPSA pretest and MPSA student posttest in the form of description items. Data obtained from the results of the pretest and posttest were analyzed to find out the magnitude of the increase in MPSA in the experimental and control classes. Data processing begins with testing the statistical requirements needed as a basis for testing hypotheses, namely the normality test of the research subject's data distribution and the homogeneity test for each group of data tested. Furthermore, certain types of statistical tests are determined according to the problem, namely t test, one-way ANOVA test, and two-way ANOVA.

3. Results and Discussion

MPSA Data Description

To obtain a description of the quality of MPSA students, the data were analyzed descriptively to find out the mean and standard deviations of students' overall MPSA N-Gain scores and based on KAM (high, medium, low. Descriptive statistics of N-Gain MPSA students are presented in Table 2.

Table 1. Descriptive Statistics of MPSA N-Gain

Data Group	Learning	N	Mean N-Gain (g)	Std. Deviasi
All	PBL	91	0,682	0,135
	Konvensional	92	0,559	0,119
KAM High	PBL	17	0,875	0,084
	Konvensional	18	0,711	0,099
KAM Medium	PBL	63	0,664	0,079
	Konvensional	63	0,548	0,069
KAM Low	PBL	11	0,482	0,068
	Konvensional	11	0,376	0,061

Based on the results of descriptive statistics MPSA data in Table 1 shows that: 1) overall the average increase in MPSA of students who received PBL learning was higher than students who received conventional learning; 2) the average increase in MPSA for High KAM group students who received PBL learning was higher than students who received conventional learning; 3) the average increase in MPSA for KAM Medium students who received PBL learning was higher than students who received conventional learning; and 4) the average increase in MPSA for low KAM group students who received PBL learning was higher than students who received conventional learning.

Increased MPSA

To find out whether the increase in MPSA of students who get PBL learning is better than students who get conventional learning is reviewed as a whole and based on KAM (high, medium, low) an average difference test of N-Gain MPSA is performed before the prerequisite test is normality test and homogeneity test. The results of normality test, homogeneity test and average difference test (t-test) of N-Gain MPSA students are reviewed Overall and based on KAM (high, medium, low) with the help of the IBM SPSS 23.0 for windows program can be presented in Table 2.

Table 2. Summary of N-Gain Statistical Test for Increased MPSA

Data Group	Learning	N	Normality Test	Homogeneity Test	Average Difference Test
All	PBL	91	0,719	0,393	0,000
	Konvensional	92	0,794		
KAM High	PBL	17	0,232	0,008	0,000
	Konvensional	18	0,596		
KAM Medium	PBL	63	0,240	0,899	0,000
	Konvensional	63	0,247		
KAM Low	PBL	11	0,995	0,012	0,001
	Konvensional	11	0,750		

Based on the results of the statistical tests in Table 2 show that the data: 1) as a whole; Significance value (sig. 1-tailed) N-Gain MPSA score of students is less than 0.05 so it can be concluded that MPSA students who get PBL model learning are better than students who get conventional learning. This shows that PBL learning contributes better than conventional learning; 2) High KAM; Significance value (sig. 1-tailed) N-Gain MPSA score of students is less than 0.05 so it can be concluded that MPSA students who get PBL model learning are better than students who get Conventional learning (using a scientific approach). This shows that PBL learning contributes better than conventional learning; 3) KAM Medium; Significance value (sig. 1-tailed) N-Gain MPSA score of students is less than 0.05 so it can be concluded that MPSA students who get PBL model learning are better than students who get Conventional learning (using a scientific approach). This shows that PBL learning contributes better than conventional learning; and 4) Low KAM; Significance value (sig. 1-tailed) N-Gain MPSA

score of students is less than 0.05 so it can be concluded that MPSA students who get PBL model learning are better than students who get Conventional learning (using a scientific approach). This shows that PBL learning contributes better than conventional learning.

The results of this study indicate that the increase in MPSA of students who get PBL learning is better than students who get conventional learning reviewed as a whole and based on KAM. This shows that PBL learning is better for improving MPSA students reviewed in its entirety and based on KAM (high, medium, low) compared to Conventional learning. Significantly increased MPSA students who got PBL model learning were higher than students who got conventional learning scientific approaches. This result is relevant to the results of research conducted by Daulay (2017) and Suhery (2013) in the form of increasing students 'mathematical problem-solving abilities that are taught with a problem based learning higher than increasing students' mathematical problem-solving abilities that obtain conventional learning. This is because PBL model learning has a sequence of activities that begin with a problem that must be solved or sought by a student to solve. These problems can come from students or may also be given by teachers. Students will focus learning around the problem, with another meaning, students learn theories and scientific methods in order to solve problems that are the center of attention, so that will result in students really understanding certain knowledge.

Interaction between Learning Models (PBL and Conventional) with KAM level to Increase MPSA

The results of the test of whether or not there is an interaction between learning and KAM level to increase student MPSA are presented in Table 3.

Table 3. Two Way Anova Test Results

<i>Source</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig. (2-tailed)</i>	<i>H₀</i>
Learning	1	0,223	34,535	0,000	Rejected
KAM	2	0,898	139,211	0,000	Rejected
Learning *KAM	2	0,104	16,144	0,000	Rejected

The calculation results of the data contained in Table 4 obtained the level of significance ($\text{sig.} = 0,000 < \alpha = 0,05$), then H_0 is rejected, meaning that there is an interaction between the learning model (PBL and Conventional) with the level of KAM to MPSA. This shows that learning and KAM together have an influence on MPSA students. Graphically, the interaction between the learning model and KAM with MPSA can be seen in the following figure 2.

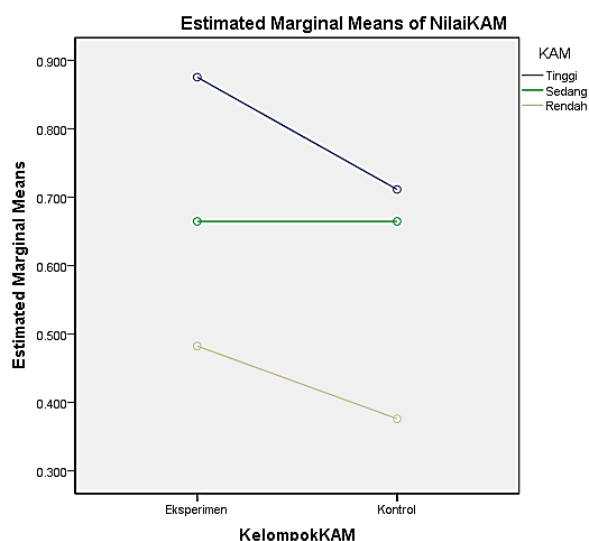


Figure 2. Interaction Diagram

In Figure 1 it can be seen that the N-Gain MPSA students of the experimental group who received PBL learning and the control group who received conventional learning at high KAM were higher than moderate and low KAM, and moderate KAM was higher than low KAM. This shows that the interaction of learning with KAM affects MPSA.

The results of this study indicate that there is an interaction between the Problem Based Learning model and conventional learning with the level of initial mathematical ability (high, medium, and low) to the mathematical problem solving ability (MPSA). It means that the interaction of learning model with KAM level gives a significant influence on the difference in MPSA increase. This result is relevant to Wulandari's research (2017) which states that there is an influence of interaction between problem based learning and situation based learning and the level of KAM students in achieving students' mathematical problem-solving abilities. A similar sentiment was also conveyed by Munawaroh, et al. (2015) that there is an interaction between Problem Based Learning and the initial ability of mathematics to improve students' mathematical problem-solving abilities.

The interaction of PBL and Conventional models with a significant level of KAM is caused by several factors, including: 1) a pleasant learning atmosphere; 2) students study together; 3) PBL and Conventional models can help students whose abilities are lacking so that they better understand and understand; 4) the use of PBL and Conventional models to provide the characteristics of the similarity of the concepts given by the teacher with the concepts accepted by students; and 5) the teacher tries to control each individual with the help of peer tutors on PBL and conventional learning in mathematics. This is in line with the atmosphere of the classroom environment that is responsive and supports the learning process, so there will be interactions between students and teachers as well as students and students that can improve students' ability and reasoning skills. Based on the above data analysis, it can be understood that PBL model

learning and conventional learning can increase MPSA students, both high, medium, and low groups.

Difference in MPSA Improvement in terms of student KAM level (high, medium, and low)

The results of the test whether there is a difference in the increase in MPSA of students who get the Problem Based Learning (PBL) learning model in terms of KAM level is carried out using the One Way Anova test with the help of the IBM SPSS 23.0 for windows program presented in Table 4.

Table 4. One Way Anova ANOVA Test Results

	<i>Sum of Squeres</i>	<i>Df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.(2-tailed)</i>
Between Groups	1,094	2	0,547		
Within Groups	0,549	88	0,006	87,567	0,000
Total	1,643	90			

Based on the calculation results of the data contained in Table 4, the significance level obtained ($\text{sig.} = 0,000 < \alpha = 0.05$), then H_0 is rejected, meaning that there are differences in N-Gain MPSA for students who get PBL learning in terms of KAM students. Because the Anova test results show a significant difference, the next test is to see which groups are different, with the Post Hoc Test. From the Test of Homogeneity results that the variants of the three groups are the same or homogeneous, then the follow-up test (Post Hoc Test) used is the Bonferroni test. Following are the Post Hoc Test results presented in Table 5.

Table 5. Post Hoc Test Results

(I) KAM	(J) KAM	Mean Difference (I-J)	Std. Error	Sig.
High	Medium	.12639*	.015350	.000
	Low	.36186*	.021857	.000
Medium	High	-.12639*	.015350	.000
	Low	.23547*	.018563	.000
Low	High	-.36186*	.021857	.000
	Medium	-.23547*	.018563	.000

The calculation results of the data contained in Table 6 show that the level of MPSA significance of high level students is 0,000, then $\text{sig} < \alpha = 0.05$, a moderate level 0,000, then $\text{sig} < \alpha = 0.05$, and low level 0.001, then $\text{sig} < \alpha = 0.05$. This means that H_0 is rejected. This means that there are significant differences in MPSA scores in terms of high, medium and low level KAM.

The results of this study indicate that there are differences in MPSA students who get PBL model learning in terms of the KAM level of students. Because the Anova test results show differences, it can be concluded that the increase in MPSA is also caused by differences in the level of KAM students have. This is in

line with the results of research conducted by Jatisunda (2016) that there are differences in the improvement of students' mathematical problem-solving abilities that are learning with contextual approaches when viewed from the students' KAM category (high, medium, low).

The results of the analysis showed that there were significant differences in the improvement of mathematical problem-solving abilities between high, medium, and low KAM group students. The higher KAM students, the higher the improvement of students' mathematical problem-solving abilities. This means that to get an increase in high mathematical problem-solving abilities, students must have a high initial mathematical knowledge. If not, even though then their mathematical problem-solving abilities are increasing, but the increase is not too large, although still significant. The results of this study further clarify the role of KAM students in increasing student MPSA.

4. Conclusion

Based on the results of research and discussion that has been presented, the following conclusions can be drawn: 1) improvement in Mathematical Problem Solving Ability (MPSA) students who get Problem Based Learning (PBL) are better than students who get conventional learning reviewed as a whole and based on Initial Ability Mathematics (KAM) significantly; 2) there is a significant interaction between learning models (PBL and Conventional) with KAM level to significantly increase MPSA; and 3) there is a difference in the increase in MPSA of students who get PBL learning in terms of KAM level significantly.

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