

Mathematical Communication Skills Reviewed from Self-Efficacy by Using Problem Based Learning (PBL) Model Assisted with Manipulative Teaching Aids

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Article Info

History Articles

Received:

July 2018

Accepted:

August 2018

Published:

April 2019

Keywords:

*learning aids manipulative,
matematisal
communication,
problem based learning,
self-efficacy*

DOI

<https://doi.org/10.15294/jpe.v8i1.25311>

Abstract

The purposes of this study were to determine the effectiveness of PBL model assisted with the manipulative teaching aids towards the mathematical communication skills, and to find out the self-efficacy based on the dimensions of magnitude, strenght, and generally. This study applied mixed method type of research with concurrent embedded design. The sample in this study is 9 students consist of 3 students in the magnitude dimension, 3 students in the strength dimension, and 3 students in the generally dimension that had been determined based on the written and oral Mathematical Communication Ability Tests (TKKM). The instruments used to collect data in this study consists of learning aids or devices such as, written TKKM Tests, questionnaire sheet and interview guidelines. The techniques of collecting data were conducted by using questionnaires, tests and interviews. The effectiveness was described based on (1) the average completeness test of 0.436; (2) the average difference test of 2.867; and (3) N-gain test of 0.468. The results of this study showed that learning conducted by using problem based learning model assisted with manipulative teaching aids is effective toward the mathematical communication skills. In addition, by using problem based learning model assisted with manipulative teaching aids can improve self efficacy in its every dimensions, including: the dimensions of magnitude obtain an average of 82.32; the dimension of strength gained an average of 80.37; and the dimensions of generally get an average of 81.78.

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[p-ISSN 2252-6404](#)

[e-ISSN 2502-4515](#)

INTRODUCTION

Mathematics is a subject that has an important role in education since it can equip students to think logically, analytical, systematic, critical and creative. National Council of Teachers Mathematics (2000) mentions five process standards in math skills must be given by the student, one of those skills is mathematical communication. Mathematical communication is the ability to assist the students to get the knowledge into their own thoughts and develop, also be able to express the mathematic ideas and strategies correctly and be able to interact with others (Isabel & Ana, 2017).

Someone who has good communication skills mathematically, it will support the mathematical abilities, for example problem solving abilities. With good communication skills, then a problem will more quickly be presented with good persentation and which can be harnessed to solve a problem (Henry, et.al. 2016). In other words, mathematical communication is one of the requirements to be able to solve a problem in mathematics, because if students are not able to communicate well and are not able to interpret the mathematical concept then the problem can not be solved properly.

Results of research conducted by Osterholm (2006) showed that students appear to have difficulty in reading comprehension, than did students only focused on a small portion of the text and think this part is the core of the problem. Students do not understand the issues contained in the matter, so that students need guidance in understanding the problem.

Based on interviews with the classroom teachers of grade IVA and IVB of SD NegeriPesarean 01, Adiwerna, Tegal, it was found that the students' mathematical communication ability is still low and still not meet the expectations. Students are still not able to express mathematical ideas in a coherent, than did students are still difficulties in understanding mathematical concepts. Besides, students of Class IVA still have low self-efficacy, it is supported by the interview resultwith the teacher of class IVA that states there are still many

students who cheated the other students' answers who felt more clever than him. Research carried out by Lunenburg (2011), mentions that self-efficacy will affect the desire to learn and determine one's objectives. Therefore, self-efficacy is crucial grown in students to inculcate self-confidence of students that he/she was capable of in facing of a problem. If seen by the dimensions of self-efficacy, students self efficacy can be measured by three kinds of dimensions, namely magnitude, strenght, and generally (Bandura, 1997).

Someone who has high self-efficacy, or good self efficacy, then these students will be assured to the achievement of something, whereas for students who have low or bad self-efficacy, then these students believe that they are not able to solve a problem (Brophy & Wentzel, 2014). This is in line with the research of Yulita, et al. (2014), who considers that the success of the learning can be affected by the character of students who take the lesson, one of which is self-efficacy, the higher self-efficacy, the greater the effort of the student and the power and tenacity in solving problems.

Someone who has a high self-efficacy then such person will not easily give in solving a problem, because students will have motivation in doing this problem so that it will bring high enthusiasm and confidence. The ability of self-efficacy of students need to be sharpened properly so that the student is not easy to give up in facing of a problem (Nurika & Rudiana, 2012), as seen in Figure 1.

In order to be able to properly communicate knowledge, then students should be able to construct knowledge in advance that idea or ideas can be expressed mathematically as well (Jonah, et.al., 2013). The use of model is very important to help teachers in designing the desired strategy. This shows the importance of using the learning model that is capable of supporting the activities of problem-based learning and group discussion later in this lesson to the student interaction. One alternative of learning models that can be used is the model of PBL. This PBL learning model is a model of problem-based learning where there is a group

discussion therein and guided by the teacher (Rotgans & Schmidt, 2011).

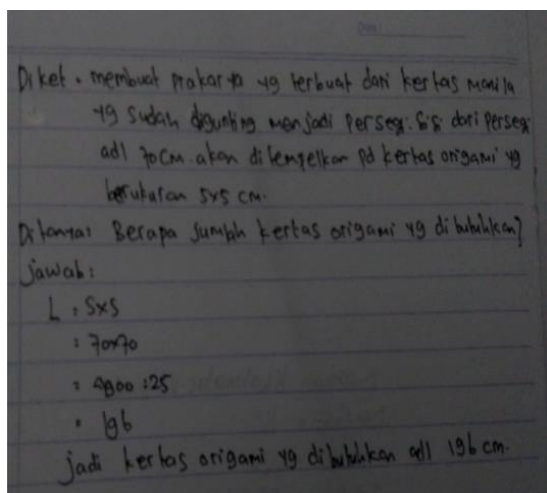


Figure 1. Results of The Written TKKM Students E-11 Who Have High Self-Efficacy

To achieve maximum success is also needed some manipulative teaching aids which is aims to facilitate students in understanding the concept of the material to be delivered. The result of the research conducted by Afriyanti (2015) and Widi (2017) by using manipulative learning tolls in the laerning activity will attract students' attention and help them in understanding the concept of mathematic which is considered abstract.

Based on the previous description, the purpose of this study were to determine the effectiveness of PBL model assisted with manipulative teaching aids in improving the mathematical communication skill, and to find out the self efficacy in terms of three dimensions, magnitude, strenght, and generally. Based on the previous description, the purpose of this research is to know the effectiveness of PBL learning model-assisted props manipulative mathematical communication skills in improving both oral or written, and to know the self-efficacy in class IVA viewed from three dimensions i.e magnitude, strength, and generally.

The effectiveness of this research analyzed through (1) learning device that will be used has a good criteria that have been validated by Prof.Dr. Hardi Suyitno, M.Pd and Prof.Dr. Kartono, M.Si; (2) learning in experiment class

using assisted PBL manipulative props model can achievethe minimum score; (3) average mathematical communication ability in experiment class using assisted PBL manipulative props model over the KKM; (4) mathematical communication skills in students' experiment class which using assisted PBL manipulative props model higher than that of the control classes which using the conventional learning model.

Mathematics is one branch of science that has a very high degree of difficulty, this is because the students still think math is a subject in which there is an abstract and confusing settlement. Therefore, teachers should be keen in choosing learning model that corresponds to the material to be delivered. This is due to that students are able to enhance students' understanding and can turn the atmosphere of active learning, creative, and fun. PBL learning model is one method of learning based on constructivist of a real problem in students' real life and can be implemented cooperatively (Hanik, et al. 2013).

As mentioned by Woolfolk (2018),the better students in achievement can identify the model of learning by the teacher, the greater the impact on the self-efficacy. Good learning process must involve a variety of situations that support, where students were able to experiment or test a variety of things to solve a concept such material, manipulating objects that exist around the school and the environment students, manipulating symbols and asking questions, and seek answers itself so that it can develop its own ideas to be discussed with friends in the group and communicating the results in front of the class. Ideas or concepts that have been discussed with the group should be perceived by the sense of responsibility for the response. To solve problems, students can be organized in small groups as a team to use a variety of skills as a means to obtain information, communicate, and integrate a variety of information (Duch, et al. 2001). By involving students directly toward solving the problem, then the material presented will be easier to hit in the minds of students.

Hmelo-Siver (2004) said that PBL learning objectives includes, to build a knowledge base; to

develop students' problem-solving knowledge; to enhance lifelong learning skills; to make effective collaboration; as well as to motivated student in learning intrinsically. Therefore, the use of PBL model with manipulative learning tool is very helpful in developing the concept of the material, especially for the elementary school grade.

METHODS

The design used in this study is a mixed methods, which is a combination of a quantitative and a qualitative research. This study applied a combination research design or concurrent embedded design. In this study, quantitative research was taken as the primary method, whereas the qualitative research was taken as the secondary method.

Population in this study were the fourth grade students of SD Negeri Pesarean 01 in the second semester of academic year of 2017/2018 consisting of two classes. Grade IV A as the experimental class taught by using PBL learning model assisted with manipulative teaching aids and Grade IV B as the control class taught by using conventional learning models. The selection of the samples in this study was done by using a purposive sample method.

In this study, 9 students will be taken as a research object based on various dimensions of self-efficacy. On the magnitude dimension, there are 3 students with average achievement of 84.35, on the strength dimension there are 3 students with average achievement of 82.32, and there are 3 students on the generally dimension with average achievement of 80.37. The sampling test results based on TKKM oral and written scores before learning begins. This study seeks to understand the level of mathematical communication ability on the dimensions of self-efficacy.

The source of data in this study consists of questions sheet to examine written TKKM on each students; interview to find out students' ability on oral TKKM and students' self-efficacy questionnaires. The data also add the mathematic communication observation, documentations, and the result of students interview.

RESULTS AND DISCUSSION

This study had been done in five meetings at both experiment class and control class. The syntax of the PBL models directs to a book written by Martinis (2013). The results are shown as follows.

Completeness Test of Learning

Normality test was used to determine whether the sample studied is in normal distribution or not. Normality test used in this study by using SPSS 16.0 by using Kolmogorov-smirnov. The results obtained indicated the sig 0.074. Therefore the value of the sign. $0.074 > 0.05$, it can be concluded that the samples come from populations with normal distribution. Having obtained the distribution data normal, the next step is to test the homogeneity.

Homogeneity Test was used to determine whether the data in the experimental class and the control class has the same variant after being treated with the use of different learning models. Based on the homogeneity test using the Test Levene's Test with a significance level of 5% was obtained acceptable results as much as 0.685. Because the nulai greater than 0.005 ($0.436 > 0.05$) H_0 accepted, so it can be concluded that the experimental variance equal to the variance control class

The average completeness test was used to determine whether students have reached KKM as much as 75%. Based on the calculation as in Appendix 11 shows $Z_{value} = 2.11$. With real difficulty level of 5%, therefore obtained $Z_{value} = z(0.5-.05) = 1.64$. Since $Z_{value} > z(0.5 - \alpha)$ it can be concluded that H_0 rejected and H_1 accepted. Therefore, it can be interpreted that the mathematical communication skills by using PBL model assisted with manipulative teaching aids has reached the classical completeness of 75%.

Difference testis usually used to know whether there is a difference between experiment class and control class. Based on the results of calculation, obtained $t = 2.867$. Because $2.867 > 0.05$ This implies that H_0 is rejected and H_1 is accepted. Therefore it can be concluded that the

average of mathematical communication skills by using the model of PBL assisted with manipulative teaching aids is more than the average of mathematical communication skill by using conventional learning models.

On the problem-based learning, students will be trained to think critically in solving a problem. This is useful when students discovered a problem with higher level and they will not be desperate. Problem-based learning is the learning that is designed to help students in solving problems effectively, thus making the students are motivated intrinsically that will form the basis of knowledge for students (Padmavathy & Mareesh, 2013).

Learning achievements obtained by the students can be influenced by several factors, including the PBL learning model that can attract learners in acquiring an interest in learning. PBL learning not just read, listen to the facts and concepts delivered by teacher, but can construct and synthesize a problem based on knowledge and experience gained by students in the real world (Downing, et.al. 2009). Moreover, to gain knowledge of the concept of matter, in learning to use manipulative teaching aids. Manipulative teaching aids are also useful to help teachers explain something that is considered abstract for students and can make a conceptual understanding (Ojose & Sexton, 2009).

N-gain test was used to determine the magnitude of the increase in students' mathematical communication ability after the given PBL model assisted with manipulative teaching aids. The data used for this test is to test the value of pretest and post test of mathematical communication skills. Based on the results of tests on the experimental class gained an average N-gain testat 0.468 and included in the good category. It can be concluded that there is an increase in students' mathematical communication skills by using PBL model assisted with manipulative teaching aids.

Mathematical Communication Skills of Students

The mathematical communication skills in this study were conducted twice, namely on

written and oral mathematical communication. The results of written and oral TKKM can be seen in Table 1 below.

Table 1. The Result of Written and Oral TKKM

Descriptive statistic	TKKM written	TKKM oral
Pretest	67.56	64.62
Posttest	80	84.35

Based on Table 1, it can be seen that there was an increase in written and oral TKKM, the average at pretest of written TKKM is 67.56, whereas, at posttest it increased to 80. The increase in written TKKM occur since students had been able to master the concept and the area of flat figure so that the students' self confidence increasing. This is in line with the research conducted by Afria (2016) with high self-confidence, it can result in students in being able to communicate ideas and visions to the problems that they experienced.

The verbal mathematical communication skills in this study were conducted after students finished working on the written TKKM questions, it is indicated by the test results obtained during the pretest verbal TKKM average of 64.62. Whereas, the results of oral TKKM after learning by using PBL model assisted with manipulative teaching aids was at 84.35. The research results of the TKKM by using PBL models assisted with manipulative teaching aids/tool is higher than by using the usual PBL model, such as the research conducted by Saputro (2017) which has achieved mastery learning that is equal to 72.

PBL learning models assisted with manipulative teaching aids can improve oral TKKM since by using the PBL model, students are asked to think high-level that is solving existing problems and then communicating with their friends. Similar to the results of research conducted by Pratiwi, et al. (2017) the application of PBL learning models can improve social skill through group discussion in solving a problem presented by the teacher. Therefore, with the PBL learning model, there will be good interaction among friends so that students will more easily to understand the concept of the material presented

Self-Efficacy of Student Based on Their Level of TKKM

Measurement of self-efficacy in grade IV A was divided into three dimensions: magnitude, strenght, and generally. Distribution of self-efficacy questionnaire conducted before learning and after learning with their actions of PBL model assisted with manipulative teaching aids.

To facilitate the students' self-efficacy questionnaire analyzes, it was done by the following steps: (1) summing the scores of self-efficacy questionnaire; (2) calculating the average (mean) and standard deviation (standard deviation) of self-efficacy questionnaire; (3) categorizing the value of self-efficacy that has been obtained by the students into various dimensions. The results are presented in Figures 4, 5 and 6.

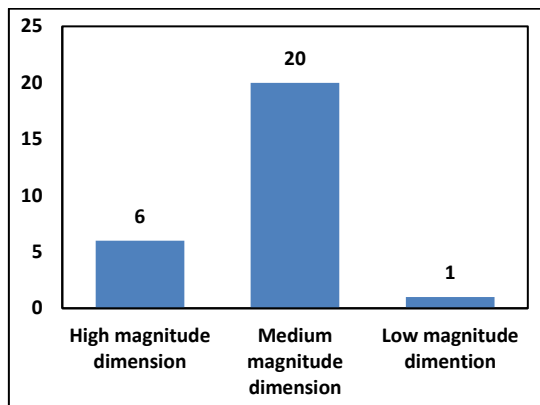


Figure 4. The Level of the Dimension of Magnitude

Based on the results of self-efficacy in figure 4 showed that the average level of the students on the dimensions of the generally showed in the magnitude dimensions as 82.32, which is in the medium category. There is an increase before the subjects were given PBL model assisted with manipulative teaching aids which was only 61.05, considered in the low category.

On the dimension of magnitude increased due to the PBL model assisted with manipulative teaching aids can attract students who initially did not interest in the subjects of mathematics that are considered abstract, to be more interest because of the PBL models and manipulative

teaching aids students are taught about the concept of the material.

In addition, students were able to account for the answer and be able to explain back in front of other students. Working groups can provide the widest possible opportunity for students to gain confidence in the ability of its students to communicate ideas or mathematical ideas, therefore, the understanding concepts of students will be better than before (Orthon, 2004).

Students who have a high magnitude of the interest have high confidence in completing the task, in addition students were also able to see a difficult problem as a challenge that must be gone through with full responsibility. However, students who have a low magnitude of the commensal and confidence to problem solving will be low so that it will make students easy to give up in facing of difficult problems.

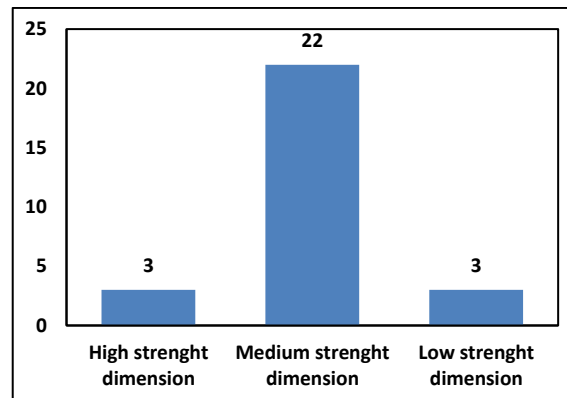


Figure 5. The Level of Dimensions of Strength

On an average dimension of strenght also increased, which had averaged 61.67 with the low category, to 80.37 with moderate category. Students who have high strenght will courage to try new challenges and able to address a problem in a different way, than did students with high strenght dimension they are able to associate with the subject matter of his life experience making it easier for students to think concretely and easy to understand. As for students who have a low strenghtthen students will feel frightened and insecure in the face of new challenges so that students are not able to work on a problem. Therefore, for students who have a low strenght,

they will be more tenuous to perceived belief in solving problems or finds a high difficulty.

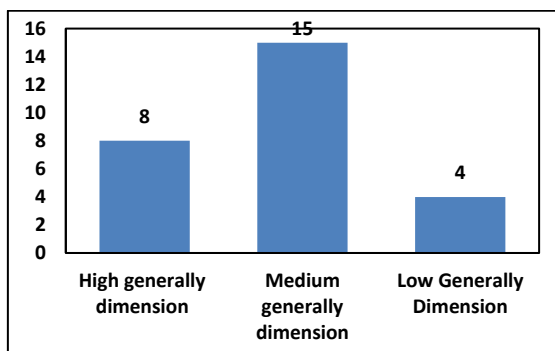


Figure 6. The Level of Dimensions of Generally

The dimension of generally the dimensions showed average result of 59.11 with a low category, being 81.78 with moderate category. In the dimension of generally, emphasize on the students' achievement goal to solve or complete problem or TKKM essay.

For students who have a high generally, students will be persistent in solving a problem and have a high motivation in doing the task. Students who have a low generally, students tend to be easy to give up when they saw a problem that exists. In the spacious dimensions of generally associated with a person's success or achievement in addressing or solving the problem under certain conditions. In the dimension of generally, it relates to the area or achievement of someone's success in overcoming or solving problems under certain conditions. Students in the dimensions of strength relate to the strength of the students when getting a difficult problem, this is due to that students have different strengths in dealing with a problem.

In self efficacy there is a difference in a person acting in facing of a problem. As research conducted by Ogunmakin & Akomolafe (2013) that self-efficacy will affect student achievement. Therefore, if there are students who have low self-efficacy should be given special care to foster self-confidence. The use of the learning model of PBL assisted with manipulative learning tool has very significant role in improving the self efficacy of students in facing of some problem well and unhurried.

CONCLUSION

Based on the results of the research and discussion described in the previous session, it can be concluded that. Learning by using PBL model assisted with manipulative teaching aids or learning tool is effective. The average of mathematical communication skills in grade IVA by using PBL model assisted with manipulative teaching aids have reached 75% of the classical completeness.

Students who have high self-efficacy, have high confidence and motivation, whereas, students who have low self-efficacy have less confidence and motivation so that they need guidance from the teacher to optimize their abilities. The use of PBL models assisted with manipulative teaching aids can also increase motivation and activeness of students so that a sense of confidence in students will improve and always enthusiastic in following the learning process.

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