European Journal of Educational and Development Psychology
Vol.12 No.3, pp.50-63, 2024
ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

Applying Scaffolding Technique in Problem Based Learning Model on Students' Mathematics Problem Solving Ability

Mohamad Salam
Universitas Halu Oleo

La Ndia
Universitas Halu Oleo

La Misu
Universitas Halu Oleo

Jafar Jafar
Universitas Halu Oleo

doi: https://doi.org/10.37745/ejedp.2013/vol12n35063 Published December 31, 2024

Citation: Salam M., Ndia L., Misu L., and Jafar J. (2024) Applying Scaffolding Technique in Problem Based Learning Model on Students' Mathematics Problem Solving Ability, *European Journal of Educational and Development Psychology*, Vol.12 No.3, pp.50-63

Abstract: *This study aimed at: (1) describing factors that influence the low mathematical problemsolving abilityand the average improvement of each indicator of mathematics problem solving ability;(2) finding out the effect of applying scaffolding technique in PBL model on mathematics problem solving ability. The subject of this study was grade VIII studentsat SMPN 5 Kendari. Qualitative and quantitative methodswere used in this study.The results of this study were: (1) factors that influence the low mathematical problem solving ability arethe studentsrarely trained questions which related to problem-solving and the learning model used by the teacher was not suitable for teaching mathematical problem solving. The average improvement of each indicator of mathematics problem solving ability by using PBL modeland DI model are: (a) understanding the problem 57.2 to 76.9 and 56.8 to 59.3; (b) solving problem 52.4 to 75.8 and 51.6 to 57.3; (c) answering problem 40.4 to 65.8 and 41.2 to 47.5; (2) studentswho were taught with PBL model have higher score than students who were taught with DI model, so there is an effect of the application of PBL model in improving mathematics problem solving ability of students of SMP 5 Kendari..*

Keywords: problem-based learning, scaffolding technique, mathematics problem solving

INTRODUCTION

The focus of mathematics learning in schools ranging from elementary school to high school is a problem-solving approach. This is in line with Jonassen's (2010) opinion

ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

that the main focus in mathematics learning is the problem solving approach. The problem solving approach is implemented to provide sufficient supplies to students to have the ability to solve various forms of mathematics problems. Besides, it will also be useful to gain knowledge and the formation of ways of thinking and behaving in solving problems faced (Sudia, et. al., 2014). Kay (2008) research results analyze the developments that will occur in the 21st century and identify 5 new conditions or contexts in life, each of which requires certain competencies. One of the results of the analysis is to anticipate global challenges required mathematics problem solving ability. In addition, problem solving ability is one part of high-level thinking skills in which it should be taught in mathematics learning. Therefore, mathematics problem solving is an important thing to be given to students in learning mathematics.

Problem solving is the embodiment of a mental activity consisting of various skills and cognitive actions intended to get the right solution (Kirkley, 2003). This will result in the ability of each person to solve problems differently. A problem that is difficult and challenging for someone, may not be a problem for others and may not be a problem for the person concerned at different times. Therefore, the problem in mathematics is relative.

According to Dindyal (2005), a situation is called a problem if there are several obstacles to the ability of the problem solver. The existence of these constraints causes a problem solver to not solve a problem directly. Dindyal (2005) describes a problem as a situation that requires solution and someone does not have a real tool or path to get a solution.

Problem solving is still difficult to understand for students and this is also a phenomenon that occurred at SMPN 5 Kendari. This is shown by the average results of the preliminary test on mathematics problem solving ability conducted by researchers at the time of the preliminary study, which obtained an average value of 36.48. based on the information from the teacher, it shows that the contributing factor is the lack of training in questions about mathematics problem solving ability and the learning model used by the teacher is not suitable to improve students' mathematics problem solving ability. Information from the teacher about the causes of low problem solving ability must be proved, by asking for information from the students. To obtain information from students about the factors that cause low problem solving ability, it must be done in depth interviews. The selection of interview methods is based on the advantages of the interview method in gathering information about the factors that cause students' low mathematical problem solving abilities. These advantages are: (1) allows researchers to make careful observations of students' performance or attitudes; (2) allows researchers to investigate deeply about the factors that cause students' problem solving abilities to be low; (3) allows students to provide detailed information about what they are doing or thinking; (4) provide clarity about students' thinking which is usually not apparent from their writing (Charles, et al, 1997). Besides having advantages, the interview method also has weaknesses, namely: (1) takes a lot of time; (2) requires carefully selected questions and asked precisely at the right time; (3) asking questions to students while he is working on solving problems can limit his ability; and (4) does not provide standard information that allows researchers to compare between individuals (Charles, et al., 1997). In this study the weaknesses of the interview method are minimized, which is done by arranging the questions carefully and asking the right questions at the right time.

To improve mathematics problem solving skills, an appropriate learning model is needed. One of the learning models that can be used to improve students' mathematics problem solving ability is a problem-based learning model (Zejnilagić-Hajrić, et. al., 2015). For a further description, the term problem-based learning model is abbreviated as PBL. PBL model is one of learning models that allow students to actively participate in the learning process and will produce better students' performance, including mathematics problem solving ability. Theoretically, PBL is included in cognitive learning theory and constructivism approach. In the application of PBL, students are directed to connect new information with the knowledge they have had previously, then build knowledge and expand it into new schemes through collaborative learning (Jonassen and Hung, 2012).

PBL is an instructional pedagogy that provides students with the tools to solve problems through the use of real world issues. The PBL process begins with an unstructured problem that the students must solve. After reviewing the problem, students identify information they already know as well as information they need to learn in order to find a solution. The three necessary components are students as the learners, the instructor as the tutor, and the problem as the context (Carrió, et. al., 2011). The key learning outcomes are learning and applying new information, structuring information for future use, developing cognitive skills, and becoming lifelong learners (Woods, 2012).

PBL is an instructional approach that enables learners to conduct research, integrate theory and practice, and apply knowledge and skills in order to develop a solution to a defined problem (Savery, 2006). Arends (2008) says that PBL is a learning that has the essence of presenting a variety of authentic and meaningful problem situations to students. Therefore, the role of the teacher in PBL is to present a variety of authentic problems so that students are required to be active in solving those problems. Solving problems is done by discussing in small groups together and exchanging information between one student and another, so that problems can be solved. The same thing was said by Ferreira &Trudel (2012), PBL is a learning approach in which students work together to find solutions to complex problems. More specifically, the PBL facilitator guides the development of higher-order thinking skills through the use of open-ended and complex questions. The facilitator encourages all group members to justify their thinking and guide them to discuss each others' ideas (De Simone, 2014).

The positive impacts of PBL have been well documented: (1) PBL can enrich students learning outcomes, which will better prepare them for the work environment (Deeter-Schmelz, et.al., 2002); (2) PBL allows the learners to take an active role in their education, encourages concept application, and provides intellectual growth through strategic decision making (Yeo, 2008); and (3) Specifically, PBL encourages students to use learned knowledge to arrive at a solution (Mykytyn et. al., 2008), holds students accountable for their own learning and the learning of the classmates (Chagas et al., 2012), and allows students to explore more than one right answer (Karantzas, et. al., 2013).

Previous research suggests PBL self-directed learning skills (e.g., Thomas & Chan, 2002), analytical and reasoning skills (e.g., Michel, et. al., 2002), interpersonal skills (e.g., Kumar & Natarajan, 2007), improves long-term knowledge retention (e.g., Strobel & Van Barneveld, 2009), problem-solving skills (e.g., Kanet & Barut, 2009), and attitudes towards the course subject (e.g., Ferreira & Trudel, 2012).

In the implementation of mathematics problem solving learning, students must be assisted so that students understand the mathematics concepts that will be used in solving mathematics problems. One way to help students in understanding mathematics concepts is by giving scaffolding. Vygotsky (Hardjito, 2010) provides ideas about Zone of Proximal Development (ZPD) and Scaffolding. ZPD is defined as the distance between the actual and potential development of a higher potential that a person has (Lipscomb, et. al., 2004; Septrianik, et. al., 2014). To reduce the gap between the level of actual development and the level of potential development, in the learning theory by Vigotsky can be done with scaffolding. Vygotsky asserts that students must be given scaffolding to achieve a higher level of potential development in solving mathematics problems (Hardjito, 2010). Scaffolding in this research is giving a number of assistance to students during the initial stages of learning and then reducing the assistance and providing opportunities for students to take on increasingly large responsibilities as soon as they are able to solve the problem themselves (Lambas, 2004).

Cultural environmental factors have an important role in the development of human traits. This is in accordance with John's opinion (2010) that the cultural environment and social interaction have an important role in the development of human traits and types. Furthermore it is stated that students should learn through interaction with adults and peers who are more capable. This social interaction spurs new ideas and enriches students' intellectual development. Students’ intellectual development refers to the process by which a person who is learning step by step acquires expertise through interaction with adults or peers who are more skilled (Slavin, 2000). These two theories proposed underlie the provision of scaffolding in mathematics problem solving learning.

The use of scaffolding in mathematics problem solving learning has a certain level or hierarchy. Anghileri (2006) proposes three levels or hierarchies of the use of scaffolding which are special supports in learning mathematics problem solving, namely: (1) environmental provisions (classroom organization, artifact such as blocks); (2) explaining, reviewing and restructuring; and (3) developing conceptual thinking.

Based on the above descriptions, it can be said that PBL model and scaffolding technique can improve mathematics learning outcomes, including mathematics problem solving ability. This is supported by several research results related to the application of PBL model and scaffolding techniques in an effort to improve mathematics problem solving ability. The result of a study Sari et. al. (2014), showed that the increasing problem solving ability of students are based on direct instruction, and PBL model has positive impact on developing students' mathematics problem solving ability.

The result of a study by Hasan & Upuh (2016) showed that there was an increase in the quality of mathematics learning outcomes through PBL model using scaffolding in class VIII students of SMPN 3 Makassar in academic year 2015/2016. The results of Darma's study (2017) showed that there was a difference in mathematics problem solving ability between the students facilitated with PBL model and direct instruction model (hereinafter abbreviated as DI). The study results by Saragih & Habeahan's (2014) showed that: (1) the increase of mathematics problem solving ability and creativity of students who were taught with PBL learning was higher than DI model; and (2) the students' answers were taught with PBL were more varied and better than DI models.

This study aimedat: (1) describing factors that influence the low mathematical problemsolving abilityand the average improvement of each indicator of mathematics problem solving ability;(2) finding out the effect of applying scaffolding technique in PBL model on mathematics problem solving ability.

METHODS

The methods used in this study were two kinds, namely qualitative methods and quantitative methods. Qualitative methods were used to explore in depth about the factors that affect the low ability of mathematical problem solving abilities of students of SMP 5 Kendari. To explore in depth about the factors that influence the low mathematical problem solving abilities of students by using interview techniques. Interviews were conducted on six students, namely one student who had high ability in the experimental class and the other wasfrom the control class; one student who had moderate ability in the experimental class and the other wasfrom the control class; one student who had low ability in the experimental class and the other wasfrom the control class.

Quantitative methods were used to describe students' mathematical problem solving abilities from the two research groups, namely the first group as the experimental class and the second group as the control class.This study was a quasi-experimental study. The reason was because not all variables that affect students' mathematical problem solving abilities were examined. The design in this study waspre-test-post test control group design. The population in this study were all Grade VIII students of SMPN 5 Kendari consisting of eleven parallel classes and the sample was taken by students from two parallel classes, namely class VIII-B which consisted of 36 students and class VIII-D which consisted of 35 students. The reason for determining the sample in this study was to take students from two parallel classes who had an average summative math test for the odd semester in academic year 2017/2018 which were relatively the same, namely 65.41 and 64.78.

To determine the experimental class and the control class in this study used simple random sampling technique. Based on the random results, Class VIII-B was determined as an experimental class and Class VIII-D as a control class. Determination of experimental class and control class using simple random sampling technique. The focus of this study was to look at the average improvement of each indicator of students' mathematics problem solving ability after being taught with scaffolding technique embedded in PBL model and students taught with DI model. Therefore, before applying scaffolding technique embedded in PBL and DI models, the two samples were given a pre-test previously about questions of mathematics problem solving ability. The average pre-test of mathematics problem solving ability of Class VIII-B was 41.7 and Class VIII-D was 49.7. After that, Class VIII-B as an experimental class was taught with scaffolding technique embedded in PBL model and class VIII-D as a control class was taught with DI model. After being taught eight times for each class with the Pythagorean Theorem material, the two classes were given a post test about questions of mathematics problem solving related to the Pythagorean Theorem. To see the average improvement in each indicator or Normalized Gain (N-Gain) the mathematics problem solving ability from the pre-test results to the post test results descriptively used the N-Gain criteria in Table 1.

Table 1. Normalized Gain (N-Gain) Criteria

N-Gain	Criteria
$N - Gain > 0{,}7$	High
$0{,}30 \leq N - Gain \leq 0{,}7$	Moderate
$N - Gain < 0{,}3$	Low

The hypothesis in this study was: the average improvement of each indicator of mathematics problem solving ability of students taught with scaffolding technique embedded in PBL model is higher than the students taught with the DI model. Statistically this hypothesis is formulated as follows:

$H_0: \mu_1 = \mu_2$ while $H_1: \mu_1 > \mu_2$
Information:

$H_0 : \mu_1 = \mu_2$ (there is no difference in the average improvement in each indicator of mathematics problem solving ability between students taught with scaffolding technique embedded in PBL model and students taught with DI model).

$H_1 : \mu_1 > \mu_2$ (average improvement for each indicator of mathematics problem solving ability of students taught with scaffolding technique embedded in PBL model higher than students taught with DI model).

The decision making criteria for $\alpha = 0.05$ are as follow:

a. If $\frac{sig\ (2-tailed)}{2}) \geq \alpha = 0{,}05$ then H_0 is accepted.

European Journal of Educational and Development Psychology
Vol.12 No.3, pp.50-63, 2024
ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

b. If $\frac{sig\ (2-tailed)}{2} < \alpha = 0{,}05$ then H_0 is rejected.

RESEARCH RESULTS

The preliminary data of this study were qualitative data from interviews with six students. Data from in-depth interviews with six students about the factors that influence the low ability of students' mathematics problem solving ability conducted by the Researcher (P) on each Research Subject (SP) are presented below. Sample result of interviews with research subjects (SP-1) students who are highly skilled in the experimental class is listed below:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-1 : The problem of mathematical problem solving is rarely taught, Sir.

P : Are there other things that cause low mathematical problem-solving abilities?

SP-1 : (Thinking). The way teachers teach mathematics related to problem solving is not appropriate.

P : Is there anything else?

SP-1 : No more sir.

Footage of the results of the interviewer's Research with the Subjects of the two (SP-2) students who are highly capable in the control class are:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-2 : Problem solving is rarely taught, Sir..

P : Are there other things that cause low mathematical problem-solving abilities?

SP-2 : The way teachers teach mathematics related to problem solving is not appropriate.

P : Is there anything else?

SP-2 : That's it, sir.

Footage of the results of the interviewer's Research with the third Research Subjects (SP-3) students who were of moderate ability in the experimental class were:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-3 : Mathematical problem solving is rarely taught,Sir.

P : Are there other things that cause low mathematical problem-solving abilities?

SP-3 : The way teachers teach mathematics related to problem solving is not appropriate.

P : Is there anything else?

SP-3 : That's it, sir.

Footage of the results of interviews of Researchers with Research Subjects four (SP-4) students who are of moderate ability in the control class are:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-4 : Problem solving problems are rarely taught, Sir.

P : Are there other things that cause low mathematical problem-solving abilities?

SP-4 : The way teachers teach mathematics related to problem solving is not appropriate.

P : Is there anything else?

SP-4 : No more sir.

Footage of the results of interviews of Researchers with Research Subjects five (SP-5) students who were of low ability in the experimental class were:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-5 : Mathematical problem solving questions are rarely given,Sir.

P : Are there other things that cause low mathematical problem-solving abilities?

SP-5 : No more sir.

Footage of the results of the interviewer's Research with Research Subjects six (SP-6) students who are low in the control class are:

P : What makes it difficult for you to solve mathematical problem solving questions, which results in your low ability to solve mathematical problems?

SP-6 : Examples of problems solving questions are rarely given.

Q : Is there anything else that causes that?

SP-6 : No more sir.

After the interview processwas carried out before being given treatment, it was seen that the answers of the research subjects were relatively the same, namely the lack of students being trained in questions related to mathematical problem solving abilities. In addition, information is obtained that the way the teacher teaches problem solving is not right. This means that the ability to solve mathematical problems must often be trained in mathematics learning, then must apply the appropriate learning model in teaching mathematical problem solving.

European Journal of Educational and Development Psychology
Vol.12 No.3, pp.50-63, 2024
ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

The quantitative data of this study were analyzed descriptively and inferentially. Descriptive analysis was carried out to see the average distribution of improvement for each indicator of students' mathematics problem solving ability based on pre-test and post test scores in the experimental class and control class and the results are presented in table 2.

Table 2 Distribution of Average Indicators' Improvement of Mathematics Problem Solving Ability Based on Pre-test and Post test on Experiment Class and Control Class

Indicators	Experiment Class			Control Class		
	Average		*N-Gain*	Average		*N-Gain*
	Pre-test	*Post test*		*Pre-test*	*Post test*	
Understanding Problems	57.2	76.9	0.46	56.8	59.3	0.06
Solving Problems	52.4	75.8	0.49	51.6	57.3	0.12
Answering Questions	40.4	65.8	0.42	41.2	47.5	0.11

Based on Table 2, it shows that the average improvement in each indicator of mathematics problem solving ability of experimental class who were taught with scaffolding technique embedded in PBL model has increased with moderate criteria, which is $0.30 \leq$ N-Gain ≤ 0.7, while the average improvement of each indicator of mathematics problem solving ability of control class who were taught by DI model also increased with low criteria, namely N-Gain < 0.30. Based on the results of descriptive analysis, it shows that the improvement quality of each indicator of students' mathematics problem solving ability in the experimental class is higher than the quality of the improvement of each mathematics problem solving indicator of students in the control class. This shows that scaffolding technique embedded in PBL model is better than DI model to improve students' problem solving ability.

Furthermore, inferential analysis is carried out, namely to test the hypothesis of the study. To do inferential analysis, the SPSS program is used, and the results are presented in Table 3.

Table 3 Results of Statistical Analysis of Mean Difference Test for Students' Mathematics Problem Solving Ability of Experiment and Control Classes

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sid(2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	0,510	0,479	4,799	48	0,000	0,23720	0,4942
Equal variances not assumed			4,799	46,296	0,000	0,23720	0,4942

Source: Primary data is processed with the SPSS program

European Journal of Educational and Development Psychology
Vol.12 No.3, pp.50-63, 2024
ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

Based on Table 3, it is obtained that $\frac{sig\ (2-tailed)}{2} = \frac{0{,}000}{2} = 0{,}000 < \alpha = 0{,}05$ then H_0 is rejected or accept H_1. By rejecting H_0, it can be concluded that the average improvement in each indicator of students' mathematics problem solving ability in the experimental class who were taught with scaffolding technique embedded in PBL model is higher than the average improvement of each indicator of mathematics problem solving ability of students in the control class who were taught with DI model.

DISCUSSION

Based on the results of qualitative analysis, it was found that questions about mathematical problem solving are rarely trained in students and how the teachers teach problem solving is not appropriate. This means that the questions related to mathematical problem solvingability must be trained frequently and the learning model used must be appropriate, namely the PBL model.

Mathematics problem solving is still considered as difficult thing by most of students. Therefore, students' mathematics problem solving ability are still low. To improve mathematics problem solving ability, students need an appropriate learning model. One of the learning models that can be used to improve students' mathematics problem solving ability is the PBL model.

The results of this study indicate that both descriptively and inferentially, the improvement of students' mathematics problem solving ability taught with scaffolding technique embedded in PBL model is higher than the mathematics problem solving ability of students taught with DI model before and after treatment. This is because through PBL model, teachers offer a variety of authentic problems so that students are required to be active in solving problems given. In addition to the application of PBL model, students are directed to connect new information with the knowledge they have had previously, then build knowledge and expand it into new schemes through collaborative learning (Jonassen and Hung, 2012). Related to this, Arends (2008) reveales that through PBL model, solving mathematics problems is done by discussing in small groups together and exchanging information between one student and another, so that problems can be solved. The same thing, Ferreira &Trudel (2012), reveales that PBL is a learning approach in which students work together to find solutions to complex problems. In addition, students who experience difficulties in solving mathematics problems, students are given assistance by teachers and other students who have better ability.

The results of this study are supported by several other study results which show that scaffolding technique embedded in PBL model is better than direct learning model, which is related to mathematics problem solving ability. The results of study by Setiawan and Santosa (2017) showed that the use of PBL model is more effective than DI model in mathematics learning if viewed from the aspect of problem solving ability. The results of Cahdriyana's study (2016) showed that the students' ability to learn and use PBL model was better than the students taught using DI model. Abdullah's study

European Journal of Educational and Development Psychology
Vol.12 No.3, pp.50-63, 2024
ISSN:2055-0170(Print),
ISSN: 2055-0189(Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development-UK

results, et. al. (2010) showed that PBL is just as efficient as the DI model in enhancing Form Four students' mathematics performance.

Scaffolding can enhance students' creativity and thinking skills. So, in other words, learning that uses scaffolding technique is very helpful for students in building creativity in solving mathematics problems. This is in accordance with the results of a study by McCosker and Diezmann (2009) which showed that scaffolding can foster students' creativity and divergent thinking skills, and enhance their independence, sense-making and self-confidence in mathematics.

Based on the results of this study and the results of previous studies indicate that scaffolding technique embedded in PBL model can improve students' mathematics problem solving ability. Therefore, scaffolding technique embedded in PBL model can be used as an alternative of learning model to teach mathematics, especially to teach mathematics problem solving.

CONCLUSION

Based on the results of the study and discussion, it can be concluded: (1) factors that influence the low mathematical problem solving ability are the students rarely trained questions which related to problem-solving and the learning model used by the teacher was not suitable for teaching mathematical problem solving. The average improvement of each indicator of mathematics problem solving ability by using PBL modeland DI model are: (a) understanding the problem 57.2 to 76.9 and 56.8 to 59.3; (b) solving problem 52.4 to 75.8 and 51.6 to 57.3; (c) answering problem 40.4 to 65.8 and 41.2 to 47.5; (2) studentswho were taught with PBL model have higher score than students who were taught with DI model, so there is an effect of the application of PBL model in improving mathematics problem solving ability of students of SMP 5 Kendari.

REFERENCES

Abdullah, N. I., Tarmizia, R. A &Rosini Abu, R. 2010. The Effects of Problem Based Learning on Mathematics Performance and Affective Attributes in Learning Statistics at Form Four Secondary Level. *International Conference on Mathematics Education Research.* 2010

Anghileri, J. 2006. Scafolding Practices That Enhance Mathematics Learning. *Journal of Mathematics Teacher Education.* Vol. 9. pp. 33-52.

Arends, R. I. 2008. *Learning to Teach.* Seven Edition. Belajaruntukmengajar. Edisiketujuh, alihbahasa oleh HellyPrayitno dan Sri MulyantaniPrayitno. Seven edition. Yogyakarta :PenerbitPustakaPelajar.

Carrió, M., Larramona, P., Baños, J., & Pérez, J. 2011. The Effectiveness of the Hybrid Problem-Based Learning Approach in the Teaching of Biology: A Comparison With Lecture Based Learning. *Journal of Biological Education,* Vol. 45. No. 4. Pp. 229-235.

Cahdriyana, R. A. 2016. Pengaruh Model PembelajaranBerbasisMasalahTerhadapKemampuanMemecahkanMasalahMatematikaSiswa SMPN 9 Yogyakarta. AdMathEdu. Vol.6. No.2. pp. 177-188.

Chagas, I., Faria, C., Mourato, D., Pereira, G. & Santos, A., 2012. Problem Based Learning in an Online Lourse of Health Education. *European Journal of Open, Distance and E-Learning, Retrieved from*http://www.eurodl.org/index.-php?article=505

Darma, I. K. (2017). Improving Mathematics Problem Solving Ability Through Problem-Based Learning and Authentic Assessment for the Students of Bali State Polytechnic. IOP Conf. Series: *Journal of Physics: Conf. Series 953 (2018) 012099.* pp. 1 - 11

Deeter-Schmelz, D. R., Kennedy, K. N. & Ramsey, R. P. 2002. Enriching our understanding of student team effectiveness. *Journal of Marketing Education,* 24(2), pp. 114-124.

De Simone, C., 2014, Problem-Based Learning in Teacher Education: Trajectories of Change, *International Journal of Humanities and Social Science,* Vol. 4, No. 12, pp. 17-29.

Dindyal, J. 2005. Emphasis on Problem Solving in Mathematics Textbooks from Two Different Reform Movements. Johor Baru Malaysia: *The Mathematics Education into the 21st Century Project UniversitiTeknologi Malaysia, Reform, Revolution and Paradigm Shifts in Mathematics Education, Johor Baru, Malaysia,* Nov 25th – Dec 1st 2005.

Ferreira, M.M. &Trudel, A.R. 2012. The Impact of Problem-Based Learning on Student Attitudes Toward Science, Problem-Solving Skills, and Sense of Community in the Classroom. *Journal of Classroom Interaction,* Vo. 47. No. 1. pp. 23-30.

Hardjito, Djwantoro, 2010, The Use of Scaffolding Approach to Enhance Students' Engagement in Learning Structural Analysis. *International Educational Studies,* Vol. 3, No. 1, pp. 130-135.

Hasan, Nur Hasmah&Upu, Hamzah. 2016. Development of Mathematic Learning Quality Through the Implementation of Problem Based Learning Model by Using Structured Scaffolding to Grade VIII-1 Student SMPN 3 Makasar, *JurnalDayaMatematis,* Vol. 4. No.3 pp. 366-379.

Jonassen, D. H. 2010. *Designing for Problem Solving.* Curators' Professor. Missouri: University of Missouri.

Jonassen, D. H., Hung, W. 2012 Problem-Based Learning. In: Seel, N. M. (Ed.), Encyclopedia of the Sciences of Learning. Springer.

Kanet, J. J. & Barut, M. (2003). Problem-Based Learning for Production and Operations Management. *Decision Sciences Journal of Innovative Education,* Vol. 1. No. 1. pp. 99-118.

Karantzas, G.C., Avery, M.R., Macfarlane, S., Mussap, A., Tooley, G., Hazelwood, Z., & Fitness, J. 2013. Enhancing Critical Analysis and Problem-Solving Skills in Undergraduate Psychology: An Evaluation of a Collaborative Learning and

Problem-Based Learning Approach. *Australian Journal of Psychology*, Vol. 65. No. 1. pp. 38-45.

Kay, K. 2008. Preparing Every Child for the 21st Century. APEC Ed Ne–Xi'an (Symposium) Xi'an China. Januari 2017.

Kirkley, J. 2003. *Principle for Teaching Problem Solving*, Technical Paper, PlatoLearning Inc.

Kumar, M. & Natarajan, U. 2007. A Problem-Based Learning Model: Showcasing an Educational Paradigm Shift. *Curriculum Journal*, Vol. 18. No. 1. pp. 89–102.

Lambas. 2004. *MateriPelatihanTerintegrasi*. Jakarta: Departemen Pendidikan NasionalDirektoratJenderal Pendidikan Dasar dan MenengahDirektorat Pendidikan LanjutanPertama.

Lipscomb, L. Swanson, J. & West, A. 2004. Scaffolding In Emerging Perspectives on Learning, Teaching, and Technology, by M. Orey. [Online] Available: http://projects.coe.uga.edu/epltt/

McCosker, N., and Diezmann, C. M. 2009. "Scaffolding Students Thinking in Mathematics Investigations." In Australian Primary Mathematics Classroom, Vol. 14, No. 3.

Michel, M. C., Bischoff, A., &Jakobs, K. H. 2002. Comparison of problem- and lecture-based pharmacology teaching. *Trends in Pharmacological Sciences*, Vol. 23. No. 4. pp. 168-170.

Mykytyn, K., Pearson, A., Paul, S. &Mykytyn, P.P. 2008. The Use of Problem-Based Learning to Enhance MIS Education. *Decision Sciences Journal of Innovative Education*, Vol. 6. No. 1. pp. 89113.

Saragih, S &Habeahan, W.L. (2014). The Improving of Problem Solving Ability and Students' Creativity Mathematics by Using Problem-Based Learning in SMP Negeri 2 Siantar. *Journal of Education and Practice*. Vol.5, No.35. pp. 123-132.

Savery, J. R. 2006. Overview of Problem-Based Learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-based Learning*, Vol. 1. No. 1. pp. 9-20.

Septriani, N., Irwan dan Meira, 2014, PengaruhPenerapanPendekatan S*caffolding*TerhadapKemampuanPemahamanKonsepMatematikaSiswa Kelas VIII SMP Pertiwi 2 Padang, *Jurnal Pendidikan Matematika*, Vol. 3, No. 3. pp. 17-21

Setiawan, A. &Santosa, R. H. 2017. The Efectiveness of Problem-Based Learning Model in Terms of Problem Solving Skill and Mathematics Creativity. *Journal Mathematic Education.* Vol 6 No 2. pp. 41-47.

Sari, S., Elniati, S. &Fauzan, A. 2014. PengaruhPendekatanPembelajaranBerbasisMasalahTerhadapKemampuanPemecahanMasalahMatemaikaSiswaKelas VIII SMPN 1 Padang. *Jurnal Pendidikan Matematika* Vol. 3 No. 2 Part 1: hal. 54-59

Slavin, R.E., 2000, *Educational Psychology: Theory and Practice*, Edisi 6, Allyn and Bacon, Boston.

Strobel, J. & Van Barneveld, A. 2009. When is PBL More Effective? A Meta-Synthesis of Metaanalyses Comparing PBL to Conventional Classrooms. *The Interdisciplinary Journal of Problem-Based Learning.* Vol. 3. No. 1. pp. 44-58

Sudia, M., Budayasa, I. K. &Lukito, A. 2014, ProfilMetakognisiSiswa SMP DalamMemecahkanMasalah Terbuka,*JurnalIlmuPendidian Malang*, Jilid 20. Nomor 1. hal. 1- 126.

Thomas, M. & Chan, L. P. 2002. Achieving Learner Independence Using the Problem-Based Learning Approach. *Journal of Language and Linguistics*, Vol. 1. No. 3. Retrieved from http:// www.ncver.edu.au/research-/proj/-nr09600_3.pdf

Woods, D. 2012. PBL: An Evaluation of The Effectiveness of Authentic Problem-Based Learning. *Chemical Engineering Education*, Vol. 46. No. 2. pp 135-144.

Yeo, R. K. 2008. How Does Learning Take Place in Problem-Based Learning Activities in Workplace Contexts? *Human Resource Development International*, Vol. 11. No. 3. pp. 317-330.

Yohanes, Rudy Santoso, 2010, TeoriVigotsky dan ImplementasinyaterhadapPembelajaranMatematika, *Widya Warta* No. 02 Tahun XXXIV/Juli2010 . ISSN 0854-1981, hal. 23-34.

Zejnilagić-Hajrić, M., Šabeta, A. &Nuić, I. 2015. The Effects of Problem-Based Learning on Students' Achievements in Primary School Chemistry. *Bulletin of the Chemists and Technologists of Bosnia and Herzegovina*. 44, 17-2