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The Effectiveness of Problem Based Learning Model on the Ability to Solve Mathematical Problems in terms of Students' Analytical Thinking Ability

Umar Ahmad Purba[1], Zainal Azis[2]
[1]Master Program of Mathematics Education, Universitas Muhammadiyah Sumatera Utara, Indonesia
[2]Lecturer at Master of Mathematics Education, Universitas Muhammadiyah Sumatera Utara, Indonesia
Corresponding Author. E-mail: umurahmadpurba@gmail.com

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ABSTRACT

The problem that underlies this research is the low ability of students to solve problems related to math problems which results in decreased activity, innovation and creativity in learning. Based on these problems, this study aims to determine whether the PBL. Model effective in improving the ability to solve mathematical problems. This research is a quasi-experimental research with a quantitative approach. The population in this study was all grade VII students of SMPN 2 Kualasimpang in the academic year 2020/2021 while the research sample was grade VII-A students. Data analysis was carried out by using paired t-test and normalized gain . Based on the results of data analysis, the value of sig (2-tailed) is 0.000 < 0.05, which means that there is a difference in the average problem-solving ability before and after learning with the PBL model. The results of the calculation of the N-gain test above, show that the average value of the N-gain score for the ability to solve problems using the problem based learning model is 60.68%, which is included in the quite effective category. Thus H0 is rejected. This means that the problem-based learning model is effective in improving the ability to solve mathematical problems.

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INTRODUCTION

The ability to solve problems in mathematics teaching materials is an ability that is still not developed by students. Of course, this ability becomes the initial capital in the success of learning objectives, because mathematics is a basic science that is packaged in an abstract form. This is reinforced by Erman Suherman who states that problem-solving skills are one of the most important curricula because students can gain experience, use knowledge, and skills in solving a problem (Yuliasari, 2017). Ashar experienced the same thing in his research, namely mathematics is a subject that throws away students' enthusiasm and interest because it is difficult to integrate into the student's *mindset* . (Lubis, 2018) Education is an effort to create an atmosphere of learning and learning, so that students actively develop their potential and skills in response to various problems in social life. (Sugiarti, N. 2022., Hidayat, M. 2020., Sesriani, Y. 2022., Husna, F. 2022)

The results of the researcher's initial review as a mathematics teacher and interviews with mathematics teachers and homeroom teachers of class VII SMPN 2 Kualasimpang, identified several student weaknesses, including: Students' habits in practicing a problem, considering a problem easy, believing that the problem can be solved with the help of friends . There is no deep seriousness to study at school, because these students think that the learning outcomes obtained are good or not, graduation has become an absolute thing to get. The low learning outcomes of class VII students, especially in mathematics, are found in the report cards of

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elementary school class VI. The students' average math scores only reached the KKM limit. Furthermore, the UAS value for the odd semester (one) in the 2020/2021 academic year for class VII students is also low. 75 % of students experience failure in achieving the KKM in the field of mathematics at SMPN 2 Kualasimpang, which are 70.

To produce students who have reliable competence in solving problems, problem solving learning strategies are needed. Based on a review of several literatures, there are many problem-solving strategies that can be applied in learning (Prabawa, 2017) . Wankat and Oreovocz classify five levels of problem solving taxonomy, namely routine, diagnostic, strategy, interpretation, and generalization (Ngaeniyah, 2017)

The indicators that become the benchmark for problem solving abilities are (1) Identifying the problem, understanding the problem correctly, mentioning what is known and asked in the problem, (2) Planning for problem solving, stating and writing down the model or formula used to solve the problem, (3) Solve problems according to the plan, perform arithmetic operations correctly, (4) Evaluate, draw conclusions from the answers obtained and re-check the calculations obtained. (Purnamasari & Setiawan, 2019)

Teachers' efforts in overcoming problems in teaching and learning activities are to find and use learning models that are suitable and integrated with the problems at hand, namely models that involve active independent students, and train students to think analytically to build knowledge. The use of learning models is expected to be able to change the paradigm of difficult and boring mathematics students to be easy and varied. Of the many learning models presented by experts, in this context the learning model that is integrated with problems and can maximize the ability to solve mathematical problems is the *Problem Based Learning* (PBL) learning model. According to Marhaeni, *Problem Based Learning* is a learning model that adheres to a constructivist learning theory that leads students to coordinate knowledge and solve problems in learning. Then students can create a problem-solving framework, organize problems, and investigate problems (Putra, 2017) .

According to Zainal Aziz, problem-based learning adheres to the constructivist flow, which emphasizes more on student activities and makes students interact more with objects and events, so that students gain understanding. The role of the teacher in this case is only as a facilitator, not a transfer of knowledge (Azis, Z. 2016) . Arends further stated that there are 5 phases that need to be done to implement PBL. These phases refer to the practical stages carried out in learning activities with PBL, namely (1) Orienting students to problems, (2) Organizing students to learn, (3) Guiding individual and group investigations (4) developing and presenting work (5) analyze and evaluate the problem solving process (Muslim, 2017)

The use of a well-targeted learning model makes the effectiveness of learning very good. Bruner stated in his learning theory, effective learning is knowledge discovery learning carried out actively by students to produce good learning outcomes. Bruner emphasized that students actively participate in independent learning, namely discovery, experimentation, and trials to develop their knowledge (Rijal, 2016) . According to Mulyasa, effectiveness can be seen in terms of *outcomes* , including the number of graduates at the next level of education, higher school achievement, employment and income (Wulandari, A. 2016). Furthermore, according to Nana Sudjana, the effectiveness of learning can be interpreted as the success of students in achieving the goals that have been set in a learning to make maximum learning outcomes (Mushlihuddin, R. 2018).

From some of the explanations above, the effectiveness of learning can be concluded as an effort to achieve maximum results to achieve a goal. This will be proven by student learning completeness, namely KKM as a benchmark. Learning can be said to be effective if at least 80% of the number of students have obtained the KKM = 70 on learning outcomes and if the learning model can improve student learning outcomes, there is a significant difference between initial understanding and understanding after learning.

RESEARCH METHOD

The research method used by the author is a quasi-experimental method (quasi- *experimental*) with a *pretest and posttest control group design* . The research location for this thesis will be carried out at SMPN 2

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Kualasimpang which is located at Gg. Sedar, Minuran Village, Kuala Simpang City, Aceh Tamiang Regency. The number of mathematics teachers is 5 people, class VII has 4 study groups consisting of 127 students. The sample in this study is class VII A. The independent variable in this study is the PBL model and the ability to solve problems is the dependent variable. The data collection technique used is in the form of a problem-solving ability test. Data analysis techniques used are normality test, homogeneity test, hypothesis testing using *paired* T-test and N-Gian test.

RESULTS AND DISCUSSION

The results and discussion in this session are made to meet the objectives of this study, namely whether there is an effectiveness of the Problem-Based learning model on the ability to solve mathematical problems. Some of the data that can be presented from the research results are as follows: (1) pre-test of problem solving ability, (2) Post-test of problem solving ability, which is treated with PBL learning model.

The test result data in the form of the average value, standard deviation, the highest and lowest values can be seen briefly in table 1 below:

Table 1. Data Description of Ability Test Results Completing Experiment class problem

Description	Experimental class I (PBL)	
	Pre-test	Post-test
mean	63	86
Std. Deviation	11.16	8.95
The highest score	85	100
Lowest Value	36	67

Based on table 1 above, from the average value of the pre-test results, it is known that the average value in the experimental class I is 63, meaning that it does not meet the average value of the minimum completeness criteria, which is 70. This shows that before being treated in the form of a PBL learning model the ability solving mathematical problems in students in both experimental classes is still low. Furthermore, the average value of the post-test results is known that the average value in the experimental class I is 86, meaning that it has met the average value of the minimum completeness criteria, which is 70. This shows that the PBL learning model has a significant role in learning effectiveness.

Normality test

After the data is taken through a descriptive test, then the data will be tested using normality to determine the pre-test data is normally distributed. The normality test of this test uses *Kolmogorov Smirnov* using SPSS V26 which will be presented in table 2 below:

Table 2. Normality Test Results Pretest and Posttest Ability to Solve Problems in Experimental Class

Tests of Normality						
KMM Pretest	Kolmogorov-Smirnov [a]			Shapiro-Wilk		
	Statistics	df	Sig.	Statistics	df	Sig.
PBL	,149	32	,068	,947	32	,117
KMM Posttest	Statistics	df	Sig.	Statistics	df	Sig.
PBL	,117	32	,200 *	,963	32	,338

Date in table 2 above are the results of the pre-test and post-test normality tests for the ability to solve problems in the experimental class. The data will be normally distributed with the condition that sig > 0.05. After the test, both data were normally distributed, this was proven by the experimental class pre-test obtaining a significant score of 0.068 > 0.05 and 0.200 > 0.05. Thus H_0 is accepted, which means that the sample comes from a normally distributed population.

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Homogeneity Test

The pre-test and post-test data that have been tested for normality will then be tested for homogeneity using the *Levene statistic test.* The homogeneity test aims to find out that each data has a homogeneous variant; the following are the hypotheses to be tested:

H_0 = Variance in each homogeneous group

H_a = Variance in each group is not homogeneous

Results of the pretest-posttest homogeneity test of the ability to solve problems in the experimental class will be presented in table 3 below:

Table 4. Test of Homogeneity of Variances

Pretest	Levene Statistics	df1	df2	Sig.
	0.058	1	62	,810
Posttest	,470	1	62	,495

From table 4 above, the significant value of the homogeneity test of the pre-test and post-test data on the ability to solve mathematical problems is 0,810 > 0,05 and 0,495 > 0,05. It can be concluded that the table data is homogeneous. Thus H_0 is accepted, which means the variance in each group is homogeneous.

Hypothesis testing

After the prerequisite test for data analysis, it was found that the problem-solving ability data and analytical thinking skills were normally distributed and had the same variance (homogeneous), then the *paired T-test was used* to determine whether the average of the same sample group had a significant difference or not. Results *paired T-test* determined by the significance value (sig) is as follows:

1. If the value of Sig. (2-tailed) < 0.05, then H_0 is rejected and ha is accepted
2. If the value of Sig. (2-tailed) > 0.05, then H_0 is accepted and ha is rejected

Furthermore, to determine the magnitude of the increase before and after learning or learning effectiveness, the researcher used the N-gain test (*Normalized Gain).* Its function is to provide an overview of improving learning outcomes before and after learning. The amount of increase before and after learning is calculated by the N-gain formula developed by Hake as follows:

$$N - gain(g) = \frac{skor\ posttest - skor\ pretest}{skor\ ideal - skor\ pretest}$$

Table 5. Categories of interpretation of the effectiveness of N-gain in percent (%)

Percentage (%)	Interpretation
< 40	Ineffective
40 – 55	Less effective
56 – 75	Effective enough
> 76	Effective

The hypotheses in this study are:

H_0 : *Problem based learning* model is not effective in improving the ability to solve mathematical problems

H_a : The *problem based learning* model is effective in improving ability to solve math problems

To find out the difference in the average problem-solving ability before and after the PBL learning model is carried out then a *paired t-test* was performed. The following are the results of the *paired t-test* of the first hypothesis of the ability to solve problems before and after using the *problem based learning model* using the SPSS V26 application:

Table 5. The results of the paired t-test hypothesis I

Paired Samples Test				
	Paired Differences	T	df	

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		95% Confidence Interval of the Difference			Sig. (2-tailed)
		Upper			
Pair 1	Pre-test - Post-test	-18,686	-10,505	31	,000

Based on the results of data analysis, the value of sig (2-tailed) is 0.000 < 0.05, which means that there is a difference in the average problem-solving ability before and after learning with the PBL model.

After it was known that there was a significant difference in the average problem -solving ability, then to determine the effectiveness of the PBL learning model, in improving the ability to solve problems, the N-gain test is carried out. The following are the results of the N-gain test of the first hypothesis of the ability to solve problems with the PBL model using the SPSS V26 application:

Table 6. N-Gain Test Results Hypothesis 1

Descriptives

	Kelas			Statistic	Std. Error
NGain_persen	Eksperimen 1	Mean		60,6895	4,03620
		95% Confidence Interval for Mean	Lower Bound	52,4576	
			Upper Bound	68,9214	
		5% Trimmed Mean		60,8529	
		Median		62,8571	
		Variance		521,310	
		Std. Deviation		22,83221	
		Minimum		17,50	
		Maximum		100,00	
		Range		82,50	
		Interquartile Range		29,11	
		Skewness		-,217	,414
		Kurtosis		-,545	,809

Based on the results of the N-gain test calculation above, it shows that the average value of the N-gain score for the ability to solve problems using a *problem-based learning model* is 60.68 %, which is included in the quite effective category. Thus H_0 is rejected. This means that the *problem-based learning* model is effective in improving the ability to solve mathematical problems.

According to Marhaeni, *problem based learning* is a learning model that adheres to a constructivist learning theory that leads students to coordinate knowledge and solve problems in learning. Furthermore, a very important ability that every student must have is being able to solve problems in dealing with every problem (Setia Dewi, 2020).

According to Polya, there are 4 indicators of measuring student success in solving problems, namely identifying problems, planning problem solving, solving problems according to plan, and conducting evaluations. Thus, *problem based learning* is an effective model in improving students' ability to solve problems (Purnamasari & Setiawan, 2019).

In this study, from the results of the *Paired T-test, it was* found that there was a difference in the average value of the ability to solve problems before and after being treated with the PBL learning model. Based on the N-Gain test, the effectiveness of the *problem based learning model* is quite effective. In other words , the *problem based learning* model is effective in improving the ability to solve mathematical problems. this is in line with the results of Susilowati and Wahyudi's research which states that the *problem-based learning model is* effective in improving problem-solving abilities (Susilowati & Wahyudi, 2020).

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According to Susanti, PBL is a learning model that involves students to solve a problem through the scientific method stage so that students can learn knowledge related to the problem and at the same time have the skills to solve problems (Susanti et al., 2011) .

Learning the PBL model, students are accustomed to carrying out the stages of problem solving starting from identifying problems, planning problem solving, solving problems according to plan, to conducting evaluations. This is what causes the PBL learning model to be quite effective in improving students' ability to solve mathematical problems.

Analytical thinking is a process of sorting out and identifying important and relevant parts of a problem, determining a solution strategy, and drawing conclusions from the results of the settlement. *Problem based learning* (PBL) is one of the innovative learning models that can provide active learning conditions for students. PBL is a learning model that involves students to solve a problem through the scientific method stage so that students can learn knowledge related to the problem and at the same time have the skills to solve problems. Therefore, the PBL model is one of the learning models that allow students to develop analytical thinking skills.

In this study, from the results of the *Paired T-test,* it is known that there is a difference in the average value of analytical thinking skills before and after being treated with the PBL learning model. Based on the N-Gain test, the effectiveness of the PBL model is quite effective. In other words, the *problem based learning* model is effective in improving mathematical analytical thinking skills. This is in line with Ati and Setiawan's research that the PBL learning model is more effective in improving analytical thinking skills in mathematics learning (Ati & Setiawan, 2020) .

One of the steps that can be taken to improve students' problem-solving abilities is to choose the right approach and learning model that is oriented towards student competence, especially mathematical problem solving abilities. According to Efendi, an attractive and efficient learning model is needed in the learning process. One of the learning models that provide opportunities for students to develop problem solving skills is the *Student Teams Achievement learning model Division* (STAD) (Windarti, Rahmawati, & Muhtarom, 2020).

In this study, the results of the *Paired T-test* showed that there was a difference in the average value of the ability to solve problems before and after being treated with STAD type cooperative learning. This is in line with Yulia's research which states that the STAD type cooperative learning model has a positive influence on the learning process to improve problem solving abilities. However, based on the N-Gain test, the effectiveness of the Cooperative model the STAD type is less effective (Education, 2016). In other words , STAD cooperative learning is less effective in improving the ability to solve mathematical problems. this may be due to the STAD type cooperative learning only prioritizing group work, discussion and presentation, so that some group members who have relatively low academic abilities are often less active in discussions, and submit all assignments to students who have relatively higher academic abilities. this causes STAD learning to be less effective for some students.

According to Nurhamila, the deficiency in group learning is that students who have low learning motivation will choose to remain passive in their group which will have a negative effect on the group. In addition, during the learning process with the STAD type cooperative model there are no activities that are able to train students in reviewing and learning from the experiences gained so that students are not able to reflect on the solutions that have been used in solving problems (Tambunan, et al., 2020).

The ability to think analytically is the ability to think which is characterized by the ability to identify the given assumptions, the ability to formulate the main points of the problem, the ability to determine the consequences of a decision taken, the ability to detect bias based on different points of view, the ability to reveal data/definitions/theorems in solving problems, and the ability to evaluate relevant arguments in solving a problem.

In this study, the results of the *Paired T-test* showed that there was a difference in the average value of analytical thinking skills before and after being treated with the STAD type cooperative learning model. This is in line with the research of Martha and Muhyadi which states that there is an effect of the STAD type cooperative learning model on analytical thinking skills. However, based on the N-Gain test, the level of

effectiveness of the STAD-type Cooperative model is less effective. In other words, STAD cooperative learning is less effective in improving the ability to solve mathematical problems (Khalistyawati & Muhyadi, 2018).

Less effective learning this type of STAD cooperative may be due to team collaboration that has not been maximized so that only some students can effectively improve their analytical thinking skills, but some are not yet effective in improving their analytical thinking skills.

According to Slavin in Fairuz Sholeh the use of learning STAD cooperative type is based on students' different abilities, different ways of learning, different levels of willingness and motivation, by forming study groups using STAD, it is hoped that students who have differences with each other can mingle and exchange ideas, students who have the will and low interest in learning, slowly being motivated by their group friends (Purwanti & Gafur, 2018).

The learning model of the STAD Cooperative learning model is highly dependent on teamwork, the better the teamwork, the better the learning outcomes obtained, but on the other hand, if the collaboration is not established, the learning outcomes will not be optimal.

CONCLUSION

Based on the results of the research presented in the previous chapter, it can be concluded that the *problem based learning* (PBL) learning model quite effective in improving the ability to solve mathematical problems. It is proven by the paired T-test and the N-Gain test which are categorized as effective with a score of 60.68% in improving the ability to solve mathematical problems. These results were obtained based on the results of the N- Gain test, but overall learning outcomes were based on completeness KKM = 70, cooperative learning type STAD can improve problem solving skills with student mastery more than 80%.

REFERENCES

Alfiani, N., & Azis, Z. (2020). The Effect Of Open Ended Approach On Problem Solving Ability And Learning Independence In Students' mathematics Lessons.

Azis, Z. (2016). Upaya Meningkatkan Pemahaman Konsep Mahasiswa Melalui Pembelajaran Berbasis Masalah dengan Penilaian Autentik pada Matakuliah Analisa Kompleks.

Amalia, E., Surya, E., & Syahputra, E. (2017). The effectiveness of using problem based learning (PBL) in mathematics problem solving ability for junior high school students. *International Journal of Advance Research and Innovative Ideas in Education*, *3*(2), 3402-3406.

Irvan, I., & Muslihuddin, R. (2020). The Development Of Teaching Materials With Problem Based Learning On The Mathematical Statistics Subject To Improve Students' Critical Thinking Ability. *IJEMS: Indonesian Journal of Education and Mathematical Science*, *2*(1), 1-6.

Hidayat, M. 2020. Pengembangan Media Rubu' Al-Mujayyab (Instrumen Astronomi Klasik) Dalam Pembelajaran matematika. Yogyakarta : Bildung

Husna, F. 2022. Influence Model of Learning PBL and CTL on the Ability of Thingking Critical Student Learning Mathematical and Independence Junior High School. *Journal of Mathematics Education and Application (JMEA)*. 1(1) : 54-65

Lubis, A. (2018). Efektivitas model pembelajaran problem based learning terhadap kemampuan pemecahan masalah matematis siswa di kelas viii smp negeri 2 batang angkola. *JURNAL MathEdu (Mathematic Education Journal)*, *1*(3), 20-26.

Lubis, R. D., Karnasih, I., & Irvan, I. (2020). Efektifitas Model Pembelajaran ARCS Dan ARIAS terhadap Kemampuan Pemecahan Masalah Matematika Siswa. *Journal Mathematics Education Sigma [JMES]*, *1*(1), 65-72.

Lubis, W. A., Ariswoyo, S., & Syahputra, E. (2020). Kemampuan pemecahan masalah matematika melalui pendekatan pendidikan matematika realistik dan pendekatan penemuan terbimbing berbantuan autograph. *Edumatika: Jurnal Riset Pendidikan Matematika*, *3*(1), 1-12.

Mushlihuddin, R. (2018). The effectiveness of problem-based learning on students' problem solving ability in vector analysis course. In *Journal of Physics: Conference Series* (Vol. 948, No. 1, p. 012028). IOP Publishing.

Muslim, S. R. (2017). Pengaruh Penggunaan Model Project Based Learning Terhadap Kemampuan Pemecahan Masalah Matematik Peserta Didik SMA. *SJME (Supremum Journal of Mathematics Education)*, *1*(2), 88-95.

Nasution, A. E., Irvan, I., & Batubara, I. H. (2020). Penerapan Model Problem Based Learning dan Etnomatematik Berbantuan Geogebra Untuk Meningkatkan Kemampuan Komunikasi Matematis. *Journal Mathematics Education Sigma [JMES]*, *1*(1), 55-64.

Nasution, Y. S., Syahputra, E., & Mulyono, M. (2020). The Development of Learning Instrument Using Problem Based Learning Model to Improve Critical Thinking of Junior High School Students. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *3*(3), 1501-1508.

Prabawa, E. A. (2017). Analisis Kemampuan Pemecahan Masalah Ditinjau Dari Gaya Kognitif Siswa pada Model Project Based Learning Bernuansa Etnomatematika. *Unnes Journal of Mathematics Education Research*, *6*(1), 120–129.

Purnamasari, I., & Setiawan, W. (2019). Analisis kemampuan pemecahan masalah matematis siswa SMP pada materi SPLDV ditinjau dari kemampuan awal matematika. *Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang*, *3*(2), 207-215.

Putra, I. P. A. S., Dharsana, I. K., & Kusmariyatni, N. (2017). Pengaruh teori kontruktivisme model pembelajaran problem based learning (PBL) berbantuan media gambar sumber daya alam untuk meningkatkan hasil belajar IPA melalui lesson study pada siswa kelas V SDN 1 kampung baru kecamatan Buleleng kabupaten Buleleng. *MIMBAR PGSD Undiksha*, *5*(2).

Rijal, S. (2016). Efektivitas Pembelajaran Matematika Siswa Melalui Penerapan Teori Belajar Bruner. *Prosiding*, *2*(1).

Rotul Ngaeniyah, I. N. A. (2017). *Analisis Kemampuan Pemecahan Masalah Matematis Berdasarkan Teori Wankat dan Oreovocz kelas VII SMP negeri 19 Bandar Lampung Tahun Pelajaran 2015/2016* (Doctoral dissertation, UIN Raden Intan Lampung).

Surya, E., Syahputra, E., & Juniati, N. (2018). Effect of problem based learning toward mathematical communication ability and self-regulated learning. *Journal of Education and Practice*, *9*(6), 14-23.

Sesriani, Y. 2022. The Effect of Models Creative Problem Solving and Problem Based Learning to Improvability Problem Solving Students. *Journal of Mathematics Education and Application (JMEA).* 1(1) : 54-65

Suagiarti, N. 2022. The Influence of Problem-Based Learning Models on Mathematic Critical Thinking Ability of Students. *Journal of Mathematics Education and Application (JMEA).* 1(1) : 22-21

Tambunan, N., Siregar, E. Y., & Harahap, M. S. (2020). Efektivitas Model Pembelajaran Kooperatif Tipe Student Teams Achievenment Division (Stad) Terhadap Kemampuan Pemecahan Masalah Matematis Siswa SMA NEGERI 1 ANGKOLA SELATAN. *JURNAL MathEdu (Mathematic Education Journal)*, *3*(1), 61-68.

Tanjung, D. F., Syahputra, E., & Irvan, I. (2020). Problem Based Learning, Discovery Learning, and Open Ended Models: An experiment On Mathematical Problem Solving Ability. *JTAM (Jurnal Teori dan Aplikasi Matematika)*, *4*(1), 9-16.

Triana, R., & Azis, Z. (2021). The Effect of the Application of Discovery Learning and Problem Based Learning Model on Metacognitive Ability and Students' Mathematical Connections. *IJEMS: Indonesian Journal of Education and Mathematical Science*, *2*(1), 34-43.

Wulandari, A. (2016). *Efektivitas Pembelajaran Model Learning Cycle 7E Terhadap Kemampuan Koneksi Matematis Kelas VIII E SMP Negeri 1 Kembaran* (Doctoral dissertation, Universitas Muhammadiyah Purwokerto).

Yuliasari, E. (2017). *Eksperimentasi Model PBL dan Model GDL Terhadap Kemampuan Pemecahan Masalah Matematis Ditinjau dari Kemandirian Belajar The Effect Of PBL and GDL Model to Mathematical Problem Solving Ability Viewed From Self Regulated Learning Pendahuluan Pendidikan adal*. *6*(1), 1–10.