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The Effectiveness of Project Based Learning in Improving Students' Mathematics Problem Solving Ability

Budi Murtiyasa, Budiningsih

Department of Mathematics Education, Universitas Muhammadiyah Surakarta, Indonesia

*Corresponding email: Budi.murtiyasa@ums.ac.id

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Abstract: The Effectiveness of Project Based Learning in Improving Students' Mathematics Problem Solving Ability. **Objectives :** The aim of this research was to describe mathematics learning with the Project Based Learning model on mathematical problem solving abilitties in class X SMA N 1 Simo. **Methods :** In this quantitative study, two classes were taken as research subjects consisting of thirty-six students in each class, namely class X MIPA 4 and X MIPA 5. Data collection techniques was carried out with a written test of 7 essay questions that had been declared valid and reliable as well as documentation. **Findings :** The average of the experimental class with the PjBL learning model is 84.72 while the average of the control class with the conventional learning model is 65.53. **Conclusions:** The result of this research indicate that class X MIPA 5 with project based learning model treatment has better problem solving ability than class X MIPA 4 which is treated with conventional learning model.

Keywords: Project based learning model, mathematical problem solving ability.

Abstrak: Efektivitas Pembelajaran Berbasis Proyek dalam Meningkatkan Kemampuan Pemecahan Masalah Matematika Siswa. ***Tujuan :*** *Penelitian ini bertujuan untuk mendeskripsikan Pembelajaran matematika dengan model* Project Based Learning *terhadap kemampuan pemecahan masalah matematika pada siswa kelas X SMA N 1 Simo.* ***Metode :*** *Dalam penelitian kuantitatif ini mengambil dua kelas sebagai subjek penelitian yang terdiri dari tiga puluh enam siswa setiap kelasnya yaitu kelas X MI3PA 4 dan X MIPA 5. Teknik pengumpulan data dilakukan dengan tes tertulis 7 soal essay yang telah dinyatakan valid dan reliabel serta dokumentasi.* ***Temuan :*** *Rerata dari kelas kelas eksperimen dengan model pembelajaran PjBL adalah sebesar 84,72 sedangkan rerata dari kelas kontrol dengan model pembelajaran konvensional adalah sebesar 65,53. .****Kesimpulan :*** *Hasil penelitian ini menunjukkan kelas X MIPA 5 yang diberi perlakuan model pembelajaran project based learning memiliki kemampuan pemecahan masalah lebih baik daripada kelas X MIPA 4 dengan perlakuan model pembelajaran konvensional.*

Kata kunci: *Model pembelajaran project based learning, kemampuan pemecahan masalah matematika.*

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INTRODUCTION

Education is wrong one method for cultivate talent and potency self which owned by student. Education makes participant educate Becomes more understand and responsive to change world as well as development science and technology. In formal education, mathematics is one of the important fields studied by students. Eye lesson mathematics given for equip student with ability think logical, analytical, systematic, critical, creative and ability work same (Schoenfeld, 2009) Competence this required so that student own ability to endure in era globalization (Zhao, 2011; Schoenfeld, 2009). However problem in math learning is lack of opportunity student to present representation and the method alone (Silver et al., 2005). Besides that, source which could support process study student in total which very limited.

Students are expected to be able to use mathematics in everyday life, have mathematical thinking patterns and learn various types of science that emphasize logic rules and the ability to apply mathematics (Saragih & Napitupulu, 2015: 331). Mathematics is always related to every subject, whether in biology, chemistry, physics, social sciences, politics, and many more. In the socio-economic development of a country, mathematics is very closely related to it because there is knowledge about the technology needed (Fafre & Na, 2019: 436). One of the barriers for students to succeed in self-regulated learning environments is that students are used to passive environments, where they are often told by teachers at school what to learn and how to do it (Hao, Branch & Jensen, 2016, 2/16) . A good learning strategy can improve students' ability to solve math problems. Responsiveness is of the utmost importance in such a learning perspevtive; instruction is not provided or given by the teacher, it is negotiated between students and teachers collaboratively and develops as ideals of students emerge and grow (Kavanagh & Raincy,2017). Accordingly, the PjBL approach has been referred to by some scholars as a type of teacher education that focuses on educational experience and the preparation of teachers to follow instruction (Ball & Forzani,2018).

Project Based Learning (PjBL) is considered an innovative approach to learning adopted by many educators around the world (Bell, 2010; Xiangyun, Youmen & Yasameen, 2019). PjBL is one of the learning models known to students in learning mathematics. One of the characteristics of the PjBL learning model is the completion of a *project* , so that students are required to be active in completing the *project* . Coupled with group work, student activity will increase. With increased activity, the problem solving ability of students is also increasing. Chang, Lou, & Chen, (2013), said the project included research activities to make students concentrate on complex tasks. such as design, problem solving and decision making. Through PjBL students are required to be able to choose topics and presentation projects, produce final products, and solve problems related to the real world. In recent years, many K-12 schools have reported increasingly positive PjBL effects on student learning, motivation, engagement, creative abilities, and thinking skills (Wurdinger, 2016; Du, Chaaban, & Al Mabrd, 2019).

Learning mathematics moment this should can train solving problem mathematics which really needed beneficial for equip student in solving problem in life everyday . _ Solve problem this as wrong one enhancing aspect level difficulty, as process accept trouble and complete problem the. Besides that, solving problem is activity intellectual to search solution from problem which solved by using knowledge which already owned (Schoenfeld, 2014; Jonassen,

2010). With thus, solving skills problem very important and should owned students so that results study student increase.

Problems are cases that give rise to a person's desire to solve them (Aydogdu, 2014). Problem solving is one of the goals in the learning process in terms of the curriculum aspect (Cahyani & Setyawati, 2017). Saragih and Habeahan (2014) say that problem solving is part of the standard process of mathematics which is very important because in the learning and completion process students are allowed to use the abilities and experiences that they must apply in solving various or different problems. Problem solving is very useful for students, as stated by Jainuri & Riyadi (2017) that mathematical problem solving abilities help students understand concepts and make decisions about the problems they experience. Polya as quoted by Chamberlin (2008), define that problem solving could interpreted as effort look for Street out of something difficulty, reach something objective which no as well as immediately could achieved. According to Mayer (Mayer, 2013; Sutrisno, 2019), solving problem is something activity or cognitive processes which directed for reach objective who need method in the solution.

Solution problem which character qualitative and quantitative done with use understanding in field mathematics, chemical Physics, and knowledge supporter other. Importance problem solving skill student also expressed by Calendar (Paidi, 2010; Suwandi, 2016). She think that problem solving skill looked at need owned students, especially student SMA / MA because ability this can help student in taking decision which appropriate, careful, systematic, logical, and consider various corner look. Trilling & Hood (Paidi, 2010) by firm stated that the ability solving problem as part of from 7 type Skills which sued for made demands for learning outcomes in schools advanced. Para expert education from *Yosemite Community College District* (YCCD) from Mesa College also confirms that for century this, demands results study *(student learning outcomes)* in school medium covers ability solving problem, skill communicate global, *IT* skills (information *and technology),* and *soft* skills *skills* other (Paidi, 2010).

Joze (2019), in his research concluded that the application of circular geoplanes as a teaching tool, can be carried out and solved with the possibility of understanding and solving geometric problems, especially in trigonometry, is also a great support for university teachers who optimize their andragogy work. The instrument enables students to become innovative producers of their own, dynamic and imaginative conceptions of Mathematics, as well as enabling them to construct meaningful new meanings from the study of geometry.

Edi Susanto , et al (2020: 66-67) in his research it was found that there was an influence of the given learning model on problem solving abilities. The results showed that the problem solving and critical thinking skills of students who were given PjBL learning were better than expository learning. This is shown from the comparison of the average value in the experimental class which is higher than the control class.

One of the materials in mathematics that is considered difficult to understand and requires proper problem solving is trigonometry. This is supported by the results of the student's National Examination on trigonometric material which showed unsatisfactory results. Puspendik Kemendikbud 2019 data shows that the percentage of high school students who answered correctly on trigonometry material in the National Examination was 36.54%. Galadima and Yusha'u (2007), in their research found that students have low trigonometry scores due to a lack of understanding of the basic concepts, principles, terms and symbols involved. Yusha'u (2013)

identified that trigonometry is a difficult topic that challenges students.

In class X of the Science Program, students study the topics of ratios, functions, equations, and trigonometric identities. Especially in the topic of trigonometric derivative formulas and their use, students will learn at least 25 formulas that they must understand in any way, as well as concepts and formulas that they must remember when they study trigonometry in class X (Ishartono et al., 2016) .

Based on the explanation above, problems related to learning mathematics can be identified, among others, first is the problem solving ability of students who are still low; both the percentage of students who answered correctly on the trigonometry material was still low; third, there are still many students who have difficulty in working on trigonometry problems; and fourth, there are still many mathematical problems that cannot be solved using only certain formulas, but require proper procedures and deeper research.

The purpose of this study was to describe the effectiveness of the *Project Based Learning* (PjBL) learning model on the mathematical problem solving abilities of X grade students of SMA N 1 Simo on trigonometry. There are two hypotheses in this study. The first hypothesis is that there is a significant difference in the level of students' mathematical problem solving abilities between classes taught using the PjBL learning model and classes taught using conventional learning models. The second hypothesis is mathematics learning using the PjBL . learning model more effective than conventional learning models.

METHODS

Participant

The population in this study were students of class X SMA Negeri 1 Simo. The sample to be used in this study consisted of two classes, namely the experimental class and the control class. The control class is class X MIPA 4 totaling 36 students, the learning model that is usually used by teachers in schools is applied, namely the conventional learning model. The experimental class is class X MIPA 5 totaling 36 students, the PjBL learning model is applied. The sampling technique in this research is *simple random sampling technique*.

Research Design and Prosedure

This type of research is descriptive quantitative. The design of this research is quasi-experimental. The research was conducted from April 20 – May 29, 2021. The first step was to conduct a literature review and then identify and limit the problem. After the problem is identified, determine the hypothesis and then perform a pretest. The next step is to conduct an experiment, namely teaching students with different learning methods and then doing a post test. After the data is collected then the data is processed and analyzed to make a report.

Instrument

Data collection techniques were carried out through test instruments which was adapted from the mathematics learning book for class X and documentation. Before the test instrument is used for research, it is first tested in a class that is not a research sample. The tests are the Validity Test and the Reliability Test of the test instrument using the SPSS version 16.0 application *for windows* . This test is used to determine the validity of the item and the reliability of the test instrument to be used. For the validity test using the *Pearson/ Product Moment correlation formula* , while for the reliability test using the *Alpha Cronbach method* .

Data Analysis

Data analysis techniques in this study include One Way Analysis of Variance Test and Multiple Comparison Test using the SPSS version 16.0

application *for windows* . Before conducting the Variance Analysis Test, the condition is that the sample used must come from a population that is normally distributed and homogeneous. So, before conducting the One Way ANOVA test, it is necessary to have a Normality Test and a Homogeneity Test for the two samples first. Normality Test and Homogeneity Test using SPSS version 16.0 *for windows application* . For normality test using *Lilliefors* method , while for homogeneity test using *Barlett test* .

The level of problem solving ability of students in the experimental class and control class is categorized into three, namely the high category; medium category; and low category. For the high category, it means that the level of students' problem solving ability is high. For the medium category, it means that the level of problem solving ability of students is moderate. For the low category, it means that the level of students' problem solving ability is low. The criteria for each category can be seen in table 1.

Table 1. Table of problem solving ability criteria

Category	Criteria
Tall	$X > \bar{X} + \frac{1}{2}SD$
Currently	$\bar{X} - \frac{1}{2}SD \leq X \leq \bar{X} + \frac{1}{2}SD$
Low	$X < \bar{X} - \frac{1}{2}SD$

■ RESULT AND DISCUSSIONS

Validity Test and Reliability Test

Before being used for research, the test instrument was tested on 36 students outside the research sample to test its validity and reliability. Test the validity of the question instrument using the *Pearson/Product Moment correlation formula* . Trial questions as many as 8 items of description were obtained and 7 items were declared valid and 1 item was declared invalid. Invalid questions are then *dropped* or removed from the test instrument and are not included in the next calculation.

The reliability of the items was analyzed using the *Alpha Cronbach method* . Calculation of reliability as many as 7 items, the results obtained $r_{count} = 0.521$, meaning that the reliability of the items is moderately correlated with quite good interpretation.

Experiment class Frequency Distribution

The first sample is all students of class X MIPA 5 as the Experiment class. Data from the experimental class mathematics test results were used to measure students' mathematical problem solving abilities. The results of the test obtained the lowest score of 64 and the highest value of 95. Using *Sturgess's rule* , it was obtained that many classes of intervals were 6 and the length of the interval was 6, so that the data from the mathematics test results could be made with a frequency distribution . The frequency distribution table for the experimental class can be seen in table 2. The average value (mean) for the experimental class is 84.83, the median value is 86.75, the mode is 89.62 and the standard deviation is 7.8486.

The results of the calculation of each category of problem-solving ability for the experimental class are as follows, the high category is $X > 88{,}7543$, the medium category is $80{,}9057 < X < 88{,}7543$ and the low category is $X. < 80{,}9057$ From these several categories, it was found that the grouping of students' problem-solving ability levels from the test results, namely, for the high category as many as 16 students, the medium category as many as 9 students and the low category as many as 11 students. The grouping of students' problem-solving ability level categories in percentages is stated for the high category as much as 44.44%, meaning that the percentage of students who have high problem-

solving abilities is 44.44%, the medium category is 25%, meaning the percentage of students who have moderate problem-solving abilities is as much as 25%, and the low category is 30.56%, meaning that the percentage of students who have low problem solving abilities is 30.56%.

Table 2. Experimental class frequency distribution table

INTERVAL	Xi	Fi	Fk
64-69	66.5	1	1
70-75	72.5	5	6
76-81	78.5	5	11
82-87	84.5	8	19
88-93	90.5	14	33
94-99	96.5	3	36
Amount			

Description : Xi : average value, Fi : frequency, Fk : cumulative frequency

Frequency Distribution i Control class

The second sample is all students of class X MIPA 4 as the control class. Data from the control class math test results were used to measure students' mathematical problem solving abilities. The results of the test obtained the lowest score of 46 and the highest score of 85. Using *Sturgess's rule* , many classes of 6 intervals and 7 intervals of length were obtained, so that the data from the mathematics test results can be made with a frequency distribution. The frequency distribution table for the experimental class can be seen in table 3. The average value (mean) for the experimental class is 65.72, the median value is 66.5, the mode is 67.5 and the standard deviation is 9.6529.

The results of the calculation of each category of problem-solving ability for the control class are as follows, the high category is $X > 70{,}5465$, the medium category is $60{,}8935 \leq X \leq 70{,}5465$, and the low category is. $x < 60$, 8935 From these several categories, students' problem solving ability level groupings were obtained from the test results, namely, for the high category as many as 13 students, the medium category as many as 14 students and the low category as many as 9 students. In the percentage stated for the high category as much as 36.11%, meaning that the percentage of students who have high problem solving abilities is 36.11%, the medium category is 38.89%, meaning that the percentage of students who have moderate problem solving abilities is 38.89%, and the low category as much as 25% means that the percentage of students who have low problem solving abilities is as much as 25%.

Table 3 . Control class frequency distribution table

INTERVAL	Xi	Fi	Fk
46-52	49	5	5
53-59	56	3	8
60-66	63	10	18
67-73	70	11	29
74-80	77	5	34
81-87	84	2	36
total		36	

Description : Xi = average value, Fi = frequency, Fk = cumulative frequency

Normality Test Results and Homogeneity Test

Before testing the hypothesis, the research data must meet the analysis prerequisite tests, namely the normality test and homogeneity test. The normality test in this study used the *Lilliefors method* with a significance level of 5%. The data is said to be normally distributed if the significance value is greater than 0.05. The calculation of the normality test in this study uses the SPSS version 16.0 application *for windows* . The results of the normality test in this study is the significance

value for class X MIPA 4 is 0.078 and the significance value for class X MIPA 5 is 0.066. So according to the *Liliefors test* , it is stated that the assumption of the Normality Test is that the sample comes from a population that is normally distributed. The critical area or assumption rejection area is when the calculation result is smaller than the significance level. With a significance level of = 0.05 and based on calculations using the SPSS version 16.0 *for windows application, the* results obtained that the significance value for class X MIPA 4 is 0.078 greater than the significance level value, then for class X MIPA 5 is 0.066 greater than the significance level value. . The test decisions of class X MIPA 4 and class X MIPA 5 are accepted assumptions, because the results of the calculation of the significance value are greater than the significance level. From some of these descriptions, it can be concluded that the two classes come from a normally distributed population.

The homogeneity test calculation uses SPSS version 16.0 *for windows.* As a test criterion, if the significance value is greater than 0.05, it can be said that the variance of two or more data groups is the same. The results of the homogeneity test in this study is obtained for a significance value of 0.927. The assumption of the homogeneity test is that the sample is homogeneous. The critical area or assumption rejection area is when the calculation result is smaller than the significance level. With a significance level of = 0.05 and based on calculations using the SPSS version 16.0 *for windows application, the* results obtained that the significance value is 0.927 greater than the significance level. The test decision is that the assumption is accepted, because the calculation result of the significance value is greater than the significance level. From some of these descriptions, it can be concluded that the sample is homogeneous.

Hypothesis Test Results

Hypothesis testing in this study was carried out by proving the regression coefficient which was carried out to test the effect of the independent variable (X), namely the learning model carried out using the One-way ANOVA test on the dependent variable (Y), namely the ability to solve mathematical problems. So that it will be known whether the independent variable has an effect on the dependent variable. The results of the one-way ANOVA test in this study are shown in table 4.

Table 4. Results of one-way ANOVA test

Mark					
	Sum of squares	Df	mean square	F	Sig.
Between Groups	6631.681	1	6631.681	76.576	0.000
Within groups	6062.194	70	86.603		
Total	12693.875	71			

The One Way ANOVA Test Hypothesis is that there is no significant effect of the use of learning models on mathematical problem solving abilities. The critical area or hypothesis rejection area is when the calculation result is smaller than the f table value ($F_{0.05;\ 1.70} = 3.99$). With a significance level of = 0.05 and based on calculations using the SPSS version 16.0 *for*

windows application , the f value is 76.576 greater than f table. The decision of the test is that the hypothesis is rejected, because the calculation result of the f value is greater than the f table value. From some of these descriptions, it can be concluded that there is a significant effect of the use of learning models on mathematical problem solving abilities.

Multiple Comparison Test Results

Based on the results of the one-way analysis of variance in the same cell above, it was found that the hypothesis was rejected. Therefore, further testing is necessary. The further test used in this study aims to determine the difference in the average effect of each learning model. The further test used is the *Independent Sample t-test* . The test results will show the difference in the average value of the control class and the experimental class. The process of calculating the t coefficient on this *independent* sample t-test uses *the SPSS version 16.0 for Windows program* . The average results in this study are shown in table 5 and the results of the independent sample t-test are shown in table 6.

Table 5. Test results mean independent sample t-test

	Class	N	Mean	Std. deviation	Std. Error mean
Nilai	Control	36	65.53	10.171	1.695
	Eksperimen	36	84.72	8.352	1.392

Tabel 6. The result of independent sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Means Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Nilai	Equal variances assumed	.51	.48	-8.75	70	.00	-19.194	2.19	-23.57	-14.82
	Equal variances not assumed			-8.75	67.44	.00	-19.19	2.19	-23.57	-14.82

Test Assumptions The *sample t-test* is that there is no difference in the average value of the class that uses the PjBL learning model and the class that uses the conventional learning model on mathematical problem solving abilities. The critical area or the assumption rejection area is when the calculation result is smaller than the t table value = - 1.994437 or greater than the t table value = 1.994437. With a significance level of = 0.05 and based on calculations using the SPSS version 16.0 *for windows application, the* results obtained that the t value is -8.751

smaller than t table. The test decision is that the assumption is rejected, because the calculation result of the t value is smaller than the t table value. From some of these descriptions, it can be concluded that there is a difference in the average value of the class that uses the PjBL learning model and the class that uses the conventional learning model on mathematical problem solving abilities.

By paying attention to the average of the experimental class and control class, namely the experimental class with the PjBL learning model, it is 84.72 while the control class with the conventional learning model is 65.53, it can be concluded that students who are taught using the PjBL learning model have an average score. better means that students' mathematical problem solving abilities are better than students who are taught using conventional learning models.

Example of Case Analysis of Experimental Class Student Problem Solving Results

In this study, the questions given to students were questions about the test after the learning process. One example of the problem is " If is in quadrant II and tan $\alpha = -\frac{2}{3}$, the value of $\frac{\sin(90°-\alpha)-\cos(180°-\alpha)}{\tan(270°+\alpha)+\cot(360°-\alpha)}$ is.... ".

Based on the results of the test, the researcher took samples of the answers of students from the experimental class who were in the high category, namely R3 (Figure 1) and students from the control class who were in the high category, namely INA (Figure 2).

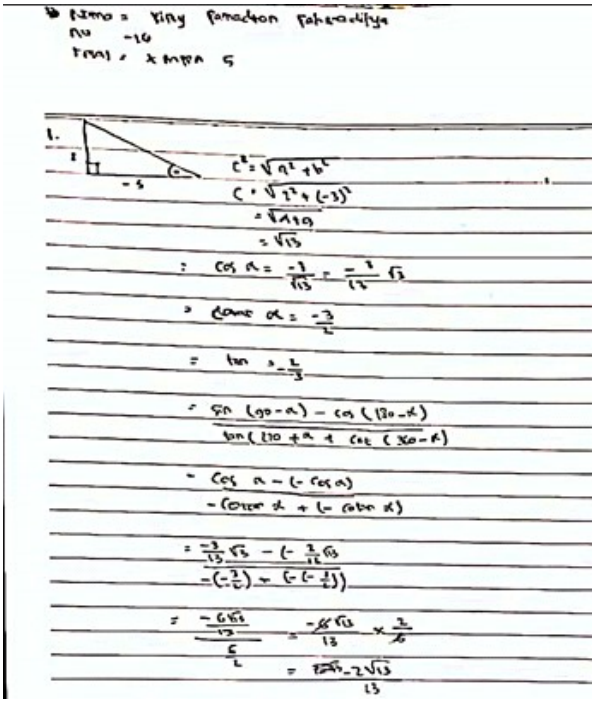

Figure 1. Answer sheet R3

Based on the first answer sheet, R3 provides an illustration correctly through pictures of the problems given and writes down what is known in the picture. R3 is able to find a solution to the problem properly and correctly. R3 is able to write answers coherently and understood.

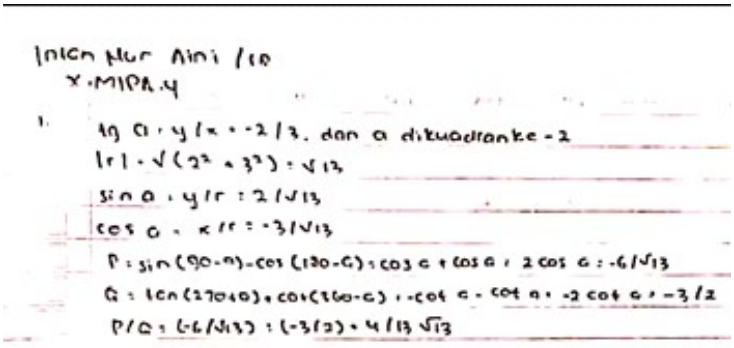

Figure 2. INA answer sheet.

Based on the 2nd answer sheet, INA has not been able to find a solution to the problem. INA writes short and inaccurate answers so that the answers written are not correct.

From the two examples of student answer sheets above and some of the previous descriptions, we can get that the problem solving abilities of students in the experimental class are better than students in the control class.

This is in accordance with research conducted by Eko Andy Purnomo, Abdul Rohma and Budiharto (2015: 24) based on the results of the comparative analysis of the problem-solving ability test results, it was found that the problem-solving abilities of students with the maple-based PjBL model *were* better than students' problem-solving abilities. before learning significantly. Similar research was conducted by Andita Putri Surya, Stefanus C. Relmasira and Agustina Tyas Asri Hardini (2018: 52), based on the results of research that has been done, showing that learning by applying the *Project Based Learning* (PjBL) model has increased. Supported by research conducted by Shi-Jer Lou, Yung-Chieh Chou, Ru-Chu Shih and Chih-Chao Chung (2017, 2402), after the sample was involved in STEM project-based learning, the affective aspects of students' creativity, including imagination, curiosity, challenge , and adventure, significantly improved.

For researchers there are no significant inhibiting factors. Several factors that hinder the course of the learning process can be overcome as the learning process progresses to completion. One of the motivating factors in implementing learning with the PjBL learning model is the enthusiasm of students in the learning process which makes the learning process run well and smoothly.

Based on the description above, it means that there is a significant difference in the level of students' mathematical problem solving abilities between classes taught using the PjBL learning model and classes taught using conventional learning models. The PjBL learning model has a better average score than the conventional learning model. Problem solving abilities in students who are given learning with the PjBL model more evenly than students who are given learning with conventional models. It can be concluded that mathematics learning uses the PjBL learning model more effective than conventional learning models for learning Trigonometry material for class X students of SMA N 1 Simo.

This is supported by field conditions in the class that was given the PjBL learning model treatment when the learning process took place, students looked more enthusiastic and tried to find solutions to the problems that had been given according to their respective groups. In this PjBL learning, students according to their groups make a summary of the material that is displayed. The material is understood by students then written in

a short, easy to understand and interesting way using their own language, guided by the textbooks owned by students and material from other sources, then a representative from each group explains what has been done. For other students, they are allowed to ask questions if there is material that they do not understand to students who are presenting. Seeing the condition of online learning like this, students are required to be more active, creative and independent. So with the PjBL learning model, In this way, students will be more creative by making summaries of learning material which will later be discussed with other friends.

While in the control class with conventional learning models, the teacher is more dominant in presenting the material then students are asked to take notes, so students tend to be passive in participating in learning. In conventional learning, students are less active because the teacher conveys the material directly with the lecture method. Learning becomes less interesting and learning is teacher-centered so that students are not accustomed to sharing opinions regarding the results of the discussion which results in uneven student problem solving abilities.

■ CONCLUSIONS

Based on the One Way Variance Analysis of data with a significance of 5% the test decision is the hypothesis is rejected and based on the discussion that has been described previously, it can be obtained that there is an effect of the use of PjBL learning models and the use of conventional learning models on the mathematical problem solving abilities of students in class X SMA N 1 Simo Trigonometry material. The PjBL learning model is better than the conventional learning model. To find out the difference in the effect of the learning model on students' mathematical problem solving abilities, a multiple comparison test was conducted using the *independent sample t-test* . Based on the *independent sample t-test test, the test* decision is that the hypothesis is rejected. This means that there is a difference in the average value of the class that uses the PjBL learning model and the class that uses the conventional learning model on mathematical problem solving abilities. Based on the calculation results, the average value of the experimental class with the PjBL learning model is 84.72, which is better than the control class with the conventional learning model of 65.53. So it can be concluded that the PjBL learning model is better than the conventional learning model, because the average value of the experimental class is higher than the average value of the control class. From the explanation of the influence and results of the students' mathematical problem solving ability levels described above, it can be concluded that learning mathematics uses the PjBL learning model more effective than conventional learning models on the problem solving abilities of class X students of SMA N 1 Simo on Trigonometry.

■ REFERENCES

Cahyani, H., & Setyawati, RW (2017). Peningkatan Kemampuan Pemecahan Masalah melalui PBL untuk Pentingnya Generasi Unggul Menghadapi MEA. PRISMA, Prosiding Seminar Nasional Matematika , 151-160. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/21635

Du, X., Youmen, C., Yasameen AL M.(2019). Exploring the Concepts of Fidelity and Adaptation in the Implementation of Project Based Learning in the Elementary Classroom: Case Studies from Qatar.International Journal of Learning, Teaching and Educational Research, 18(9), 1-22.

Hasibuan, Y. A. & Hasanah, R. U. (2022).

Analysis of the Difficulties of Junior High School Students in Solving PISA Model Mathematics Problems.Jurnal Pendidikan Progresif, 12(2), 436. DOI : 10.23960/jpp.v12.i2.202204

Hsu, P. L. & Yi-Yu, L.(2018).Using Cogenerative Dialogues to Transform Contradictions in Project-Based Learning. EURASIA Journal of Mathematics, Science and Technology Education, 14(12), 1623. https://www.ejmste.com/article/using-cogenerative-dialogues-to-transform-contradictions-in-project-based-learning-5587

Ishartono, N., Juniati, D., & Lukito, A.(2016). Developing Mathematics Teaching Devices in the Topic of Trigonometry Based on Guided Discovery Teaching Method. Journal of Research and Advances in Mathematics Education. 1(2), https://journals.ums.ac.id/index.php/jramathedu/article/viewFile/4827/3221

Jainuri, M., & Riyadi, S. (2017). Eksperimentasi Model Sinektik terhadap Kemampuan Pemecahan Masalah Matematis dan *Self Efficacy* Siswa.Jurnal Edumatica, 7(2), 51-60. https://doi.org/10.22437/edumatica.v7i02.4106

Lestari, K. E. & Yudhanegara, M. R. (2018). Penelitian Pendidikan Matematika. Bandung: PT Refika Aditama. https://scholar.google.co.idcitations?view_op=view_citation&hl=en&user=NJbU_pYAAAAJ&citation_for_view=NJbU_pYAAAAJ:2osOgNQ5qMEC

Lou, S. J., Chou, Y. C., Shih, R. C., & Chung, C. C.(2017).A Study of Creativity in CaC_2 Steamship-derived STEM Project-Based Learning. EURASIA Journal of Mathematics, Science and Technology Education, 13(6), 2387-2404. https://www.ejmste.com/download/a-study-of-creativity-in-cac2-steamship-derived-stem-project-based-learning-4776.pdf

Nasruddin., S. M., & Jahring. (2019). Implementation of Team-Assited Individualization Instructional Strategies Supported by Geogebra Software to Improve Mathematical Problem Solving Ability. Jurnal Pendidikan Progresif, 9(1), 17. DOI : 10.23960/jpp.v9.i1.201903

Özreçberoglu, N., & Çaganaga. C. K. (2018). Making It Count: Strategies for Improving Problem-Solving Skills in Mathematics for Students and Teachers' Classroom Management.EURASIA Journal of Mathematics, Science and Technology Education, 14(4), 1253-1261. https://www.ejmste.com/download/making-it-count-strategies-for-improving-problem-solving-skills-in-mathematics-for-students-and-5341.pdf

Purnomo,Eko Andy., Abdul Rohman. , dan Budiharto.(2015). Efektivitas Penerapan Model Pembelajaran *Project Based Learning* (PBL) Berbasis *Maple* Mata kuliah Kalkulus Lanjut II. *Jurnal Karya Pendidikan Matematika,* 2*(2)*, https://jurnal.unimus.ac.id/index.php/JPMat/article/view/1700/1749

Siagian, Meryance V., Sahat Saragih., Bornok Sinaga. (2019). Development of Learning Materials Oriented on Problem-Based Learning Model to Improve Students' Mathematical Problem Solving Ability and Metacognition Ability.International Electronic Journal of Mathematics Education, 14(2), 331-340.

Sugiyono.(2015). Metode Penelitian Pendidikan (Penelitian Kuantitatif, Kualitatis, dan R&D). Bandung: CV

Alfabeta. https://cvalfabeta.com/product/metode-penelitian-kuantitatif-kualitatif-dan-rd-mpkk/

Surya, A. P., Relmasira, S. C. & Hardini, A. T. A. (2018). Penerapan Model Pembelajaran *Project Based Learning* (PjBL) Untuk Meningkatkan Hasil Belajar Dan Kreatifitas Siswa Kelas III SD Negeri Sidorejo Lor 01 Salatiga. Jurnal Pesona Dasar, 6(1), 41-54. http://jurnal.unsyiah.ac.id/PEAR/article/view/10703/8432

Susanto, E., Susanta, A. & Rusdi. (2020). The Effectiveness of Project Based Learning in term of the Students' Abilities Problem Solving and Critical Thingking. Jurnal Theorems, 5(1), 61-68. https://jurnal.unma.ac.id/index.php/th

Sutrisno AB, J. (2019). Problem Solving Ability of Junior High School Students Towards Geometry : Gender and Mathematical Disposition Analysis. Jurnal Pendidikan Progresif, 9(2), 210. DOI : 10.23960/jpp.v9.i2.201923

Suwandi, T., Hasnunidah, N., & Marpaung, R. R. T. (2016). Pengaruh Pembelajaran Berbasis Masalah Open-Ended terhadap Peningkatan Kemampuan Pemecahan Masalah oleh Siswa. Jurnal Pendidikan Progresif, 6(2), 164

Velazco, D. J. M., & Padron, Y. R. (2019). Teaching Resource for the Teaching of Geometry : Circular Trigonometric Geoplane.International Electronic Journal of Mathematics Education, 14(1), 3-13.

Yusha'u, M. A.(2013). Difficult Topics in Junior Secondary School Mathematics: Practical Aspect of Teaching and Learning Trigonometry.Scientific Journal of Pure and Applied, 2(4), 161-174.