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The Effect of Problem-Based Learning (PBL) Using Video-Based Learning (VBL) on Mathematics Students' Problem-Solving Ability in SMK Negeri 14 Medan

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Abstract

The low mathematical problem-solvingability of class X students of SMK Negeri 14 Medan and the lack of application of learning models according to the latest trends are the background of this research. This study aims to determine the effect and effect size of Problem-Based Learning (PBL) using Video-Based Learning (VBL) on the mathematical problem-solvingability of students at SMK Negeri 14 Medan in a two-variable linear equation system. This research is a quasi-experimental study with a pretest-posttest control group design, where class X TEI is the experimental class, and class X TITL 1 as the control class. Data collection techniques in the form of pretest and posttest results were given to the two research classes. Furthermore, the t-test was carried out to test the hypothesis after first passing the prerequisite tests, namely the normality test and homogeneity test. The results obtained indicate that learning with the PBL model using VBL has an effect on students' mathematical problem-solvingability. Students who are taught with the PBL model using VBL have higher problem-solvingability than those taught with the direct learning model. The effect size of the treatment indicated that there was a high and consistent influence of the application of the PBL model using VBL on the mathematical problem-solvingability of students at SMK Negeri 14 Medan.
Keywords: Problem-Based Learning, Video-Based Learning, Problem-Solving ability

Abstrak

Rendahnya kemampuan pemecahan masalah matematis siswa kelas X SMK Negeri 14 Medan dan kurangnya penerapan model pembelajaran sesuai tren terkini menjadi latar belakang penelitian ini. Penelitian ini bertujuan untuk mengetahui pengaruh dan besar kecilnya pengaruh Pembelajaran Berbasis Masalah (PBL) menggunakan Video-Based Learning (VBL) terhadap kemampuan pemecahan masalah matematis siswa SMK Negeri 14 Medan pada sistem persamaan linear dua variabel. Penelitian ini merupakan penelitian quasi eksperimen dengan desain pretest-posttest control group design, dimana kelas X TEI sebagai kelas eksperimen, dan kelas X TITL 1 sebagai kelas kontrol. Teknik pengumpulan data berupa hasil pretest dan posttest diberikan kepada dua kelas penelitian. Selanjutnya uji t dilakukan untuk menguji hipotesis setelah terlebih dahulu melewati uji prasyarat yaitu uji normalitas dan uji homogenitas. Hasil yang diperoleh menunjukkan bahwa pembelajaran dengan model PBL menggunakan VBL berpengaruh terhadap kemampuan pemecahan masalah matematis siswa. Siswa yang diajar dengan model PBL menggunakan VBL mempunyai kemampuan pemecahan masalah yang lebih tinggi dibandingkan dengan yang diajar dengan model pembelajaran langsung. Besaran efek perlakuan menunjukkan bahwa terdapat pengaruh yang tinggi dan konsisten penerapan model PBL menggunakan VBL terhadap kemampuan pemecahan masalah matematis siswa SMK Negeri 14 Medan.
Kata kunci: Pembelajaran Berbasis Masalah, Pembelajaran Berbasis Video, Kemampuan pemecahan masalah

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INTRODUCTION

The industrial revolution continues to progress along with the times. Currently, the industrial revolution has reached the era of 4.0, which is marked by the presence of new technology. The industrial revolution 4.0 is shown by the collaboration between physical equipment and MT (mobile

technology), IoT (internet of things), UV (unnamed vehicles), AI (artificial intelligence), big data, and production facilities to assist data collection and analysis. Also decisions are made manually as well as automatically (Maulida et al., 2020). At the same time, the educational revolution is also in the era of 4.0, marked by an independent and student-centered learning system. The educational revolution that has occurred provides opportunities as well as new challenges that must be faced.

Another challenge facing today is the COVID-19 pandemic. The impact of this pandemic affects all community activities, including the world of education. Since March 2020, all education units in Indonesia have implemented a study from home program. The implementation of mathematics learning is carried out online by applying digital technology. This development is expected to continue to encourage the implementation of good learning as well as the achievement of learning objectives in accordance with NCTM. NCTM (National Council of Teachers of Mathematics) (Maulyda, 2020), states that the objectives of learning mathematics are; mathematical understanding, mathematical reasoning, mathematical communication, mathematical connection, mathematical representation, and problem-solving. From the learning objectives above, one of the competencies that students must possess, according to the learning objectives above, is the capacity to solve mathematical issues (problem solving).

Actually, Indonesia has a score of 379, or 72nd order , according to data from the Organization for Economic Co-operation and Development (OECD Program's for International Student Assessment (PISA) (Schleicher, 2019), which includes 77 countries with an average score of 489. This implies that Indonesian students have a very low level of mathematical ability. Furthermore, the PISA 2018 interpretation results show that pupils' problem-solving ability are still very low.

Problem-Solving ability is one of the skills that students need in everyday life. Everyone will confront challenges at some point in their lives, and it is critical for everyone, especially students, to understand how to solve problems. There are four phases of problem-solving are: 1) gaining an understanding of the problem; 2) devising a plan; 3) carrying out the plan; 4) looking back (Polya, 2004). The phase mentioned by Polya above is also an indicator of problem-solvingability in this study. The four indicators will be a measure of students' mathematical problem-solving ability.

However, the reality shows that students' problem-solving ability are still low. The low problem-solving ability of students is because students have not been able to absorb information well, do not understand the transformation of the problem, do not understand the material completely, and have weak prerequisite concepts (Rohmah & Sutiarso, 2018). There is a lack of experience of students in solving problems, and students are not careful and thorough in the work process. Furthermore, student's lack of problem-solvingability is evident when facing new math problems. Students tend to only be able to use existing formulas and, moreover, memorize examples of questions. Students are also less able to solve non-routine questions that require further thought (Suryani et al., 2020). Self-regulated learning also causes low problem-solvingability in students. Research conducted by (Mayasari & Rosyana, 2019) shows that student self-regulated learning with

mathematical problem-solvingability has a linear relationship. The greater the student's self-regulated learning, the greater their problem-solvingability. Students who have strong self-regulated learning will not give up easily (Reski et al., 2019). While (Masri et al., 2018) state that the cause of students' not being able to show optimal learning outcomes is that students feel unsure that they are able to complete the tasks assigned to them. In addition, the low problem-solvingability is also influenced by students' disinterest or hatred for mathematics (Simamora et al., 2018). The number of students who think that mathematics is difficult causes students to have difficulty understanding the formulas in mathematics, have difficulty answering questions in the form of story questions, feel ashamed to ask questions, and become lazy about learning mathematics (Ode et al., 2019). Other than the above factors, another cause of the low problem-solvingability of students is the selection of models and learning strategies used in the classroom. In addition, the teacher-centered learning model caused a lack of opportunities for students to construct their mathematical knowledge (Rinaldi & Afriansyah, 2019).

Based on the results of observations at SMK Negeri 14 Medan, which were held on February 8th and 15th, 2022, it was discovered that students were sometimes able to solve routine problems where the solution was simply to repeat a mathematical procedure that had just been learned, but had difficulty solving problems in the form of problems. According to information from a mathematics teacher at SMK Negeri 14 Medan, this is further exacerbated during the pandemic because learning takes place online. Another problem obtained from the results of an interview with one of the mathematics teachers at SMK Negeri 14 Medan is the lack of interest in student learning during the COVID-19 pandemic, where online learning is more common. The strategies that can be used to optimize students' mathematical problem-solvingability is the application of a learning model (Safithri et al., 2021).

One alternative learning model that can be used to help improve students' mathematical problem-solvingskills is the Problem-Based Learning (PBL) model. PBL basically aims to help students apply their knowledge to a problem that occurs in real life. According to (Rahman, 2018), PBL is a learning model that presents practical problems through stimuli in teaching and learning activities and is an innovative learning model that provides active learning conditions for students. The PBL model is an effective learning model that is applied in learning because students actively maximize their thinking skills. According to (Allo et al., 2019), PBL is a learning model that trains students' mathematical problem-solving skills by providing real problems. This fact makes PBL an appropriate learning model to improve mathematical problem-solving ability, in addition to active student involvement in learning. PBL consists of 5 stages or syntax, are: 1) orient students to the problem, 2) organize students for study, 3) assist independent and group investigation, 4) create and present artifacts and exhibits, and 5) analyze and evaluate problem-solving techniques (Arends & Kilcher, 2010).

One of the efforts to improve mathematical problem-solving skills is the application of supportive learning media. Learning using video media is known as Video-Based Learning (VBL). VBL is an audio-visual medium with a motion aspect that may grab students' attention and urge them to participate in learning activities (Parlindungan et al., 2020). VBL has the potential to revolutionize both how we learn and how teachers educate. Videos may assist students in picturing how something works by displaying information and features that are difficult to convey through text or static photographs. Furthermore, films can draw students' attention, inspiring and engaging them to work together more (Mohamed et al., 2015).

Based the description above, the aims of this study are: to know the effect and the effect size of Problem-Based Learning (PBL) using Video-Based Learning (VBL) on the mathematical problem-solving ability of students in SMK Negeri 14 Medan in a two-variable linear equation system. Through this research, it is hoped that there will be an effect of PBL using VBL on the mathematical problem-solvingability of students at SMK Negeri 14 Medan.

The research that was related with this study is entitled "Mathematical Problem-Solving Ability: The Impact of Mathematics Learning Videos on an E-Learning Platform" (Salsabila & Pradipta, 2021). The results showed that learning using video on the E-learning platform affected students' problem-solvingability. Furthermore, students who are taught by video have better problem-solvingskills than students who are taught by direct methods. Another research is done by (Yani et al., 2020).

METHOD

This research was conducted at SMK Negeri 14 Medan, with the population of this study being students of classes X TITL 1 (Teknik Instalasi Tenaga Listrik 1/Electrical Installation Engineering 1) as the experimental class and class X TEI (Teknik Elektronika Industri/Industrial Electronics Engineering) as the control class. The total number of students in this study was 71 students, where class X TITL amounted to 36 students and class X TEI consisted of 35 students. The type of research used is quasi-experimental and design is Pretest-Posttest Control Group Design (Sugiyono, 2019). Design of this research as following:

Table 1. Research Design

Class	***Pre-test***	**Treatment**	***Post-test***
Experimental	0_1	X	0_2
Control	0_1		0_2

Annotation:

X : Learning with the PBL model using VBL in the experimental class.

0_1 : Pre-test given to the control and experimental class.

0_2 : Post-test given to the control and experimental class.

Problem-Solvingtest was the research tools utilized to collect data for this study. The test instrument consists of 3 essay.

Validity Test

Instrument validity refers to the level of adequacy and appropriateness of the interpretation made from the assessment according to need. In short, instrument validity refers the extent to which a measuring instrument is able to measure what it is supposed to measure (Sugiyono, 2019). Based on this definition, determining the validity of the test requires evaluation from experts to validate the test instrument. The evaluation of these experts is done by determining whether each item is included in the valid, valid with revisions, or invalid categories. The experts concluded that the test instrument used was valid and suitable for use with revision. Researchers also utilize construct validation using product moment correlation in addition to validation with expert consensus. the calculated r value (Pearson Correlation), $r_{cal} > r_{table}$ (0.334), indicates that the item is valid and feasible to use. The following is an interpretation of the validation of the items in this study.

Table 2. Item Test Validity

Number of Test	r Calculated	Validity Category
1	0,645	High
2	0,614	High
3	0,602	High

Reliability Test

Reliability shows the extent to which an instrument can be trusted as a measuring tool and is reliable. A reliable instrument shows the stability and consistency of the measurement results. This means that the instrument is said to be consistent if, after measuring something repeatedly, the measuring instrument shows the same results under the same conditions (Retnawati, 2016). Based on the analysis using IBM SPSS for Windows, the following is the value of Cronbach's Alpha if the item is deleted, which shows the reliability of the item.

Table 3. Item Test Reliability

Number of Test	Reliability	Category
1	0,668	High
2	0,692	High
3	0,722	High

The value of Cronbach's Alpha based on Standardized Items using IBM SPSS Statistics for Windows is 0.686. Then the value of r is tabled at $df = N - 2$ and probability 0.05 (df = 33; α = 5%), which is 0.344. So it can be concluded that r count (0.686 $> r_{table}$ (0.344)), which means that the test instrument is reliable as a whole.

Normality Test

A normality test is the first step to analyse the data specifically. This normality test is intended to determine whether the distribution is normal in the study (the distribution in the population is normal). The normality test in this study used the Shapiro Wilk test with the help of the IBM SPSS Statistics 25 program for Windows. The level of significance in this test is 5% or 0.005 with the following conditions:

If the p-value $\geq \alpha = 0{,}05$, the distribution is normal.

If the p-value $< \alpha = 0{,}05$, then the distribution is not normal.

Homogeneity Test

To see that the two tested classes have the same basic ability, first the variance similarity is tested. The test is known as the homogeneity test. To find out the results of the homogeneity test of variance between the experimental class and the control class, it can be done using the Levene's Test with the help of the IBM SPSS Statistics 25 program for Windows.

The proposed hypothesis is as follows:

$H_0: \sigma_1^2 = \sigma_2^2$, There is no variance or homogeneous data.

$H_1: \sigma_1^2 \neq \sigma_2^2$, There is variance or not homogeneous data.

The test criteria is that H_0 is accepted if the significance value is > 0.05 or 5%, so that H_1 is rejected, which means there is no difference in variance or homogeneous data.

Hypothesis Test

The average pretest and posttest results in the experimental class and control class were tested to determine whether the mathematical problem-solving ability of students from both classes had the same ability or not. If the grouping of data is not normally distributed, then the average difference test uses the Mann-Whitney U test. Meanwhile, if the grouping of data is normally distributed, then the Independent Sample T-test is carried out.

Effect Size

To determine the effect of the application of PBL using VBL on students' mathematical problem-solvingability, it can be measured using Cohen's formula as follows:

$$d = \frac{\bar{X}_1 - \bar{X}_2}{S_{comb}} \qquad (1)$$

with

d : Effect size

$\bar{X}_1$: The mean value of experimental class postest

$\bar{X}_2$: The mean value of experimental class postest

S_{comb} : Combined standard deviation (Cohen, 1988).

RESULT AND DISCUSSION

This research was conducted from August 02nd – August 09th, 2022 and consisted of 2 meetings in each class. Each meeting consists of 160 minutes (4 x 40 minutes). Before conducting the research, the researcher prepared the instruments to be used in the two classes. The instruments prepared include lesson plans, worksheets, pretest, and posttest questions. The researcher conducts a pretest to both the experimental class and the control class before classes begin to ascertain the students' starting points. The next, researcher taught math to two distinct classes. After the learning process, the researcher gave a posttest to the experimental class and the control class. Based the

analysis, there were statistical findings as descriptive statistics. The description of students' mathematical problem-solvingability in the experimental class with the application of the PBL model using VBL and in the control class with the application of the direct learning model carried out at SMK Negeri 14 Medan is shown in the results and posttest discussion of the two classes as follows.

Table 4. Experimental and Control Class After Treatment

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Experimental	35	18,75	75,00	93,75	84,94	4,41	19,42
Control	36	16,67	70,83	87,50	78,99	4,32	18,69

According to statistical findings, pupils in the experimental class performed better than those in the control class. This is further demonstrated by the fact that the experimental class has a higher mean than the control class. After being given a treatment, pretest and posttest, the researcher did a prerequisite test such as normality and homogeneity. Normality used Shapiro Wilk and homogeneity used Levene's. The following are the results of the normality analysis using Shapiro-Wilk obtained using SPSS.

Table 5. The Result of Normality Test By Shapiro-Wilk

	Class	**Statistic**	**Sig.**	**Category**
Mathematical Problem-SolvingAbility	Pretest of Experiment	0,976	0,638	Normal
	Posttest of Experiment	0,956	0,177	Normal
	Pretest of Control	0,962	0,282	Normal
	Posttest of Control	0,960	0,208	Normal

Based on the results of the SPSS output on the normality test with Shapiro-Wilk above, it is known that the value of Sig. for the Experimental Pretest and Control Pretest is, respectively, 0,638 and 0,282. Because the value of Sig. The pretest for the two classes is > 0,05, so according to the basis for decision making in the Shapiro-Wilk test, it can be concluded that the data from the experimental class and the control class pretest are normally distributed. After the data is normal, it's done a homogeneity test. The following are the results of the homogeneity test in the experimental class and control class.

Table 6. The Result of Homogeneity Test By Levene's

	Levene Statistic	df1	df2	Sig.	Conclusion
Pretest	.104	1	69	.748	Homogen
Posttest	.028	1	69	.868	Homogen

Based on the table above, it is known that the value of Sig. for the results of the pretest and posttest is equal to 0,748 and 0,868. Because the value of Sig. > 0,05, it can be concluded that the variance of the data from the pretest and posttest results of students in the experimental class and control class is homogeneous**.**

Since the data was normally distributed and homogeneous, the mean difference was tested using the Independent Sample T-test with the help of the IBM SPSS Statistics for Windows program. The test hypotheses for the difference between the two pretest averages are as follows:

$H_0 : \mu_1 \leq \mu_2$ The mean value of mathematical problem-solvingability of the experimental class students is lower or equal to the average mathematical problem-solvingability of the control class students.

$H_1 : \mu_1 > \mu_2$ The mean value of mathematical problem-solvingability of the experimental class students is higher than the average mathematical problem-solvingability of the control class students.

The following is the output of the Independent sample t-test using IBM SPSS 25 for Windows.

Table 7. 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)
Equal variances assumed	.028	.868	5.740	69	.000
Equal variances not assumed			5.738	68.843	.000

Based on the results of the calculation of the hypothesis test, it is known that t_{cal} (5.740) > t_{table} (1.667), so that H_0 is rejected and H_1 is accepted, which means that the mathematical problem-solvingability of students who are taught using the PBL model using VBL is higher than the mathematical problem-solvingability of students who are taught by using the direct learning model in class X SMK Negeri 14 Medan. After know there is a influence in this study, effect size will calculated. The results of the effect size calculation can be seen in the table below.

Table 8. The Result of Effect Size

Effect size	Result	Percentage
d	1,3	90

From table 8, it can be seen that the calculation results obtained show that the effect size of the treatment given was 1,3 with a percentage of 90%. These results indicate that there is a high and consistent influence of the application of the PBL model using VBL on the mathematical problem-solving ability of students at SMK Negeri 14 Medan.

Discussion

This study is a quasi-experimental research that aims to determine the effect of applying the PBL model using VBL on the mathematical problem-solving ability of the students of SMK Negeri 14 Medan in terms of the assessment of the students' mathematical problem-solving ability tests, which resulted in an average difference between the experimental class and the control class. This study involved class X TEI as the experimental class and class X TITL 1 as the control class. The mathematical problem-solvingability measured in this study is a person's ability to: 1) understand the

problem; 2) devise a plan; 3) carry out the plan; and 4) look back after solving the problem. The material referred to in this study is a system of two-variable linear equations.

According to the findings of the research, the mean posttest value of the experimental class (84,94) is greater than the mean posttest value of the control class (79,99). These findings imply that students taught using the PBL model with VBL perform better students taught using the direct learning model. As a result, the PBL model with VBL has an effect on students' mathematical problem-solvingability in class X SMK Negeri 14 Medan on the material of a two-variable linear equation system. This is consistent with the findings of (Masri et al., 2018), who discovered that students taught using the PBL model had higher mathematical skills than those taught using the conventional learning model. These results are shown by the data analysis and interpretation of inferential statistics performed. Based on the effect size calculation, the PBL model using VBL has a large (90%) influence on students' mathematical problem-solving ability.

The magnitude of the effect, 90%, indicates that the application of the PBL model using VBL has a high level of impact on the mathematical problem-solvingability of students in the experimental class. Based on the results of the study, it was shown that students in the experimental class had higher achievement in solving mathematical problems than the control class. The indicator with the highest achievement is the indicator of understanding the problem. Furthermore, significant differences between the experimental class and the control class can be seen from the achievement of the indicators after carrying out the plan and checking again. Research by (Yusri, 2018), explains that these results are related to constructivism theory, which means students can think about solving problems, looking for ideas, and making decisions. Students will understand better because they are directly involved in fostering new knowledge; they will understand better and be able to apply it.

In addition to the implementation of the PBL model, the use of VBL is the reason for the achievement of the study's results. Students are drawn to learning when they see problems presented in an engaging way. Students show an interest in video elements, which helps to focus their attention on learning. This is supported by (Panjaitan & Silitonga, 2021) research, which shows that the use of video in learning has a significant influence on student learning outcomes. Problem-Solvingability is one of the learning outcomes in question.

CONCLUSION

Based on the research results obtained, it can be concluded were the application of the PBL model using VBL had an effect on students' mathematical problem-solvingability in the material of a two-variable linear equation system in class X SMK Negeri 14 Medan. Students who are taught using the PBL model using VBL have better problem-solvingability than those taught through the direct learning model. Furthermore, the effect size of the treatment given is 1,3 with a percentage of 90%. These results indicate that there is a high level influence of the application of the PBL model using VBL on the mathematical problem-solvingability of students at SMK Negeri 14 Medan.

There are some suggestion for teacher, students, and researchers, as following:

1. For teacher, this research can be used by teachers and even schools to improve students' ability and become an alternative solution when facing situations that force the re-implementation of online learning. The video given should be a video made by the teacher and show with a projector in the classroom.
2. For students, researchers suggest that students prepare before learning and continue to practice their problem-solving ability. They should also pay attention to and follow the directions given by the teacher.
3. For researchers who will use this model for continuous research, it is better to prepare and coordinate classes better.

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