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Problem Based Learning and Digital Worksheet: Can they sharpen student's problem solving skills?

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***Abstract*—** Problem solving is the focus and goal of learning mathematics. Problem solving can be developed in many ways, one of which is by using worksheets that contain heuristic problem solving procedures. Currently, the development of technology and the use of digital devices in education is very massive. However, this should not isolate students from interacting and discussing during math learning. The role of the teacher is indispensable in choosing a learning model, therefore this research will focus on the use of digital worksheets in learning mathematics education. The purpose of this study is to determine whether there is a difference in the mathematical problem solving ability of students in the experimental class who learn with a problem-based learning model with control class students who learn by using a conventional model. This research is a quantitative research with quasi experimental design. The results showed that there was a difference in the mathematical problem solving ability of students in the experimental class with the control class.

***Keywords*—** worksheet, digital, problem solving skill, problem based learning.

1. INTRODUCTION

When someone cannot use the mathematical knowledge they understand, and requires several steps to solve a mathematical problem, a mathematical problem arises [1], [2]. Therefore, mathematical problem solving skills need to be developed, and made the main focus and goal in learning mathematics [1], [3]. Mathematical problem solving contains a procedure for formulating and solving problems [4]. However, the facts show that in the process of solving mathematical problems, there is often a failure in the sequence of the heuristic process, so that the analysis process carried out does not produce an appropriate solution [1].

To unravel the obstacles in the development of problem solving skills, a program was created that aims to develop a person's heuristic ability in solving problems. This program consists of a number of booklets that include self-learning activities, techniques for making solutions, methods for changing problems, and repeated experience of the problem [5]. Another thing that can be done is to develop materials, as well as compile activities that can develop problem solving skills that are summarized in a worksheet [6].

Several studies have shown that there is great potential in education reform that focuses on digital technology, so that traditional modes of education will be completely replaced [7],[8]. These technological changes have led to new changes in education, especially in curriculum and educational technology [7],[9]. However, there has not been much research related to digital worksheets to help develop students' problem solving skills.

NCTM revealed that the use of electronic tools can help students in developing students' mathematical problem solving skills, but teachers must ensure that with these electronic tools students are not isolated to interact and discuss with other friends [3]. For this reason, in this study researchers used the Problem Based Learning model combined with digital worksheets to help students improve their problem solving skills. The purpose of this study is to determine whether there is a difference in mathematical problem solving ability between students who learn through the Problem Based Learning learning model using digital interactive worksheets and students who learn using conventional methods.

2. METHODS

This research is a quantitative research with quasi experimental design [10]. This research was conducted in one of the private high schools located in Malang Regency with a population of grade XI students. sample selection was done by randomized class. Obtained a number of 31 students in the experimental class, and 28 students in the control class.

Quantitative data collection is done through Pre-Test, digital worksheet, and Post-Test. Pre-Test was conducted to determine whether the experimental class and control class had the same initial ability.

Then a post-test was conducted to find out whether there were differences in mathematical problem solving skills between the experimental and control classes.

Quantitative research instruments in the form of pre-test and post-test questions. The pre-test questions given were related to prerequisite material before linear program learning was carried out. Meanwhile, the post-test questions used were mathematical problem solving ability tests consisting of 1 linear program problem solving problem. The post-test questions were prepared based on Polya's problem solving indicators [11], which can be seen in Table 1, while the post-test instrument can be seen in Figure 1.

Table 2. *Polya's Problem Solving Ability Indicators*

Polya's Problem Solving Stages	Indicator of Mathematical Problem Solving Ability
1. Understand the problem	Students are able to find the information contained in the problem and the information asked in the problem
2. Planning to solve the problem	Students are able to determine the solution steps that need to be taken to solve the problem as well as the reasoning
3. Implementing the problem-solving plan	Students are able to solve problems with predetermined steps
4. Rechecking the solution as a whole	Students are able to check the correctness of the results obtained from each step taken in solving the problem.

Suatu pesawat udara memiliki tempat duduk tidak lebih dari 50 penumpang. Setiap penumpang kelas utama boleh membawa bagasi 14 Kg, sedangkan untuk kelas ekonomi 6 Kg. Pesawat itu hanya dapat membawa bagasi 420 Kg. Jika harga untuk kelas utama adalah Rp.500.000 per orang, dan kelas ekonomi Rp.300.000 per orang., maka keuntungan maksimum yang dapat diperoleh oleh maskapai tersebut adalah...

Figure 1. *Mathematical problem solving ability test instrument*

Quantiative data analysis techniques were carried out on the pre-test and post-test results. Before testing the hypothesis to determine the difference in problem solving ability of the experimental class and control class, first the normality test and homogeneity test were carried out on the pre-test and post-test results. After both data were normally distributed and homogeneous, then the t-test was conducted to test the hypothesis. All data analysis was done with the help of SPSS.

3. RESULT

In this study, the data generated in the form of pre-test and post-test scores. The pre-test value is used to determine the initial ability of the subjects in the experimental and control classes before receiving treatment. Before the research is carried out, the pre-test value must meet the requirements of normality and homogeneity. The post-test value is used to determine whether there is a difference in the problem solving ability of the experimental class and the control class. Before conducting hypothesis testing, post-test data must meet the requirements of normality and homogeneity.

The first data analysis carried out was the pre-test data normality test with the Kolmogorov-Semirnov Test. The normality test was carried out to determine whether the experimental and control class pre-test data were normally distributed. Pre-test data is said to be normally distributed if the value of. Based on the data in Table 2, the value is obtained for the experimental class, and for the control class. Thus, the pre-test results of the experimental class and control class were normally distributed.

Table 2. *Pre-Test Data Normality Test Results*

Tests of Normality							
	Kelas	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
PreTest	Eksperimen	.141	31	.119	.969	31	.499

	Kontrol	.125	28	.200*	.968	28	.528
***. This is a lower bound of the true significance.**							
a. Lilliefors Significance Correction							

After the pre-test data from both classes were normally distributed, then the homogeneity test was carried out with the One Way Anova test. The homogeneity test is carried out to determine whether the subjects of the two classes come from the same population. Pre-test data is said to be homogeneous if the. Based on the data in Table 3, the was obtained. Thus, the research subjects from the experimental class and control class came from a homogeneous population.

Table 3. *Pre-Test Data Homogenity Test Results*

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
PreTest	Based on Mean	2.338	1	57	.132
	Based on Median	2.286	1	57	.136
	Based on Median and with adjusted df	2.286	1	56.999	.136
	Based on trimmed mean	2.316	1	57	.134

After analyzing the pre-test data, researchers then began to conduct research by conducting the learning process using the Problem Based Learning model accompanied by digital interactive worksheets in the experimental class, and conventional learning with the lecture method in the control class. After that, the Post-Test was conducted, then data analysis was carried out on the post-test results. Before hypothesis testing is carried out on post-test data, researchers first conduct normality and homogeneity tests as prerequisite tests.

The first data analysis performed on the post-test results is the normality test. No different from the pre-test data normality test, post-test data is said to be normally distributed if the value of.

Based on the data in Table 4, the value of for the experimental class, and for the control class. Thus, the pre-test results of the experimental class and control class were normally distributed.

Table 4. *Post-Test Data Normality Test Results*

Tests of Normality							
	KemampuanPemecahanMasalah	**Kolmogorov-Smirnova**			**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
PostTes	Post-Tes Eksperimen	.140	31	.128	.967	31	.441
	Post-Tes Kontrol	.118	28	.200*	.942	28	.124
***. This is a lower bound of the true significance.**							
a. Lilliefors Significance Correction							

After the post-test data from both classes were normally distributed, then the homogeneity test was carried out with the One Way Anova test. Post-test data is said to be homogeneous if the Sig.α value>0.05. Based on the data in Table 5, the Sig.α value=0.220>0.05 was obtained. Thus, the research subjects from the experimental class and control class came from a homogeneous population.

Table 5. *Post-Test Data Homogenity Test Results*

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
PostTest	Based on Mean	1.540	1	57	.220
	Based on Median	1.123	1	57	.294
	Based on Median and with adjusted df	1.123	1	53.906	.294
	Based on trimmed mean	1.479	1	57	.229

All post-test prerequisite tests have been met. It's time to test the hypothesis with the Independent Sample T-Test test. This test was conducted to determine whether there was a difference in the mathematical problem solving ability of the experimental class and the control class. The mathematical problem solving ability of the experimental class and control class subjects is concluded to be different if the Sig.α value <0.05. Based on the data in Table xx, the Sig.(2-tailed)=0.000<0.05 value was obtained. Thus it can be concluded that there is a difference in the problem solving ability of the experimental class and the control class.

Table 6. *Hypothesis Test Results*

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PostTest	Equal variances assumed	1.540	.220	7.463	57	.000	31.727	4.251	23.214	40.240
	Equal variances not assumed			7.364	50.515	.000	31.727	4.308	23.075	40.379

In addition to the difference in the problem solving ability of the experimental and control class subjects, the average post-test results of the experimental class were better than the control class. The average of the experimental class is 71.57 while the control class is 38.82. The average post-test results of both classes can be seen in Table 7.

Table 7. *Average post-test result of experimental and control class*

Group Statistics

	Kelas	N	Mean	Std. Deviation	Std. Error Mean
KemampuanPemechanMasalah	Eksperimen	30	71.57	13.174	2.405
	Kontrol	28	38.82	18.417	3.481

4. DISCUSSION

The results of our research show that there are differences in students' mathematical problem solving skills in the experimental and control classes. The average post-test obtained by the experimental class is better than the control class. This means that digital worksheets with problem-based learning can improve students' mathematical problem solving skills.

In learning mathematics, there are several ways to develop problem solving skills, namely by developing materials clearly according to the grade level of students and also compiling activities that can develop problem solving skills. The material development and activities can be organized into worksheets [3], [5], [6]. Other research shows that the use of worksheets can develop students' mathematical problem solving skills [12].

Dalam penelitian ini, konten lembar kerja disusun menyesuaikan pembelajaran berbasis masalah, mulai dari pemberian masalah, materi pendukung yang memuat prosedur penyelesaian, bahan diskusi, serta latihan soal. Seluruh konten tersebut disusun secara runtut dengan memperhatikan langkah-langkah penyelesaian. Hal ini dilakukan untuk memudahkan siswa dalam memahami langkah penyelesaian. Hal tersebut dilakukan karena siswa seringkali tidak dapat menemukan solusi dari suatu permasalahan diakibatkan oleh kegagalan heuristik dalam menghubungkan antar fakta-fakta yang diketahui [13]. Untuk melatih kemampuan heuristik seseorang dalam memahami proses pemecahan masalah diperlukan sebuah lembar kerja yang menarik dan memicu seseorang berlatih secara mandiri [5].

Students with less ability will feel uninterested in passive learning [14]. We can use technology to attract students, because technology, has its own role in math learning [15]. The use of technology is very suitable in learning mathematics, because it can help students develop critical thinking, creative, and problem-solving skills rather than just remembering [14].

There are several obstacles in developing mathematical problem solving skills. Students find it difficult to communicate the mathematical problems they face both orally and in writing [13]. Sehingga, lembar kerja digital ini digunakan bersamaan dengan pembelajaran problem based learning sebagai alternatif yang dapat dilakukan guru untuk membantu siswa dalam mengembangkan kemampuan pemecahan masalah matematisnya. Didalam pembelajaran problem based learning terdapat proses pembelajaran mandiri melalui diskusi, yang tidak mengisolasi siswa untuk berinteraksi.

5. CONCLUSION

Based on the results and discussion that have been presented, the conclusions of this study include:

1. There is a difference in mathematical solution ability between students who received problem-based learning treatment during mathematics learning, and students who only learn with conventional methods.
2. The average mathematical problem solving ability of students in the experimental class is better than the control class.
3. Problem Based Learning and digital worksheets can improve students' mathematical problem solving ability

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