International Journal of Elementary Education.
Volume 4, Number 3, Tahun 2020, pp. 261-269
P-ISSN: 2579-7158 E-ISSN: 2549-6050
Open Access: https://ejournal.undiksha.ac.id/index.php/IJEE

Improving Mathematics Learning Outcomes Through Problem Based Instruction

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ARTICLE INFO

Article history:
Received 2 Juni 2020
Received in revised form 12 Juli 2020
Accepted 10 Agustus 2020
Available online 28 Agustus 2020

kata kunci:
problem based instruction, hasil belajar, matematika

keywords:
problem based instruction, learning outcomes, mathematic

ABSTRAK

Masalah utama pada penelitian ini mengacu pada rendahnya hasil belajar matematika siswa. Hal ini disebabkan karena belum diterapkannya model pembelajaran yang relevan pada proses pembelajaran matematika. Penelitian ini bertujuan untuk menganalisis pengaruh model *Problem Based Instruction* terhadap hasil belajar matematika siswa kelas V SD. Penelitian ini merupakan jenis penelitian *quasi eksperimen* dengan menggunakan rancangan *Non Equivalent Control Group Design* yang dalam pelaksanaannya *pretest* hanya digunakan untuk mengetahui kesetaraan kelompok. Teknik *cluster* digunakan untuk menentukan sampel penelitian hingga terpilih 2 kelompok yang terdiri dari kelompok eksperimen serta kelompok kontrol dengan jumlah sampel yakni 87 siswa dari total 8 anggota populasi dengan jumlah siswa 243. Tes uraian dipilih sebagai instrumen pengumpulan data sehingga diperoleh nilai yang dianalisis dengan teknik analisis statistik inferensial menggunakan rumus *separated varians* pada uji-t.. Berdasarkan hasil analisis, diperoleh $t_{hitung} > t_{tabel}$ yakni 7,2909 > 2,021. Sehingga H_0 ditolak dan H_a, diterima. Dengan demikian dapat disimpulkan bahwasannya model *Problem Based Instruction* berpengaruh positif terhadap hasil belajar matematika siswa.

ABSTRACT

The main problem in this study refers to the students that have a low mathematics learning outcome. This is caused by the lack of application of relevant learning models in the mathematics learning process. This study aimed to analyze the effect of the Problem Based Instruction model on the mathematics learning outcomes of fifth-grade students. This research is a quasi-experimental research using the Non-Equivalent Control Group Design which in its pretest is only used to determine group equality. Cluster technique was used to determine the research sample until 2 groups were selected consisting of the experimental group and the control group with a total sample of 87 students from a total of 8 population members with a total number of students 243. The test description was chosen as an instrument for data collection to obtain the score, analyzed by analysis techniques inferential statistics use the formula of variance separated in the t-test. Based on the results of the analysis, t count > t table is 7.2909> 2.021. So H0 is rejected and Ha is accepted. Thus, it can be concluded that the Problem Based Instruction model has a positive effect on the learning outcomes of students.

1. Introduction

Mathematics in elementary school is very important because mathematics is one of the basic sciences (Rachmayani, 2014). Mathematics is learning that is global (international) even at the university level (Mansur, 2018). Accordance with (Aripin, 2015) which states that every level of education must be mathematics and it is in line with (Sumartini, 2016), mathematics is a subject that is required from elementary to high school levels. Mathematics is closely related to solving problems both in work and everyday life which involves a person's ability to think and analyze (Susanto, 2019). In line with that, (Isrokatun & Rosmala, 2018) also consider that critical thinking is closely related to mathematics. Adult mathematics develops rapidly because the concepts in mathematics are used to solve various problems. Mathematical concepts need to be instilled in students from an early age so that students who have provisions to solve problems, develop science and technology in the future (Kesumawati, 2008). In addition to understanding the concept of many things that can arise from the mathematic learning process (Mawaddah & Anisah, 2015). One of them is the achievement of mathematics learning objectives.

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In general, mathematics must be understood to be achieved. One of the five objectives of learning mathematics in Permendiknas No 22 Tahun 2006 (Choridah, 2013) is "problem-solving which includes the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained". This is in line with the most important target in education in the modern era, to teach and direct students to overcome any problems they are facing because they can overcome them (Sezgin & Çalýskan, 2008) . Therefore, it means that not always students in the implementation of mathematics learning are required to memorize all formulas or formulas in mathematics but the most important thing is the basic calculation skills that must be mastered to be able to solve problems (Vitoria & Monawati, 2016). So it is better if students memorize formulas combined with several problems that students may have experienced in their lives, so that the mathematics objectives previously described can be achieved because learning mathematics in schools is not only for increasing numeracy skills but also for solving problems (Lidinillah, 2008).

Mathematics affects several aspects of life so students' mathematical skills must be created and developed (Rameli et al., 2014). This development can use a challenge that teachers give to students because teachers play an important role in building student confidence in mathematics (Widjajanti, 2009), this will certainly be a start for students to try to solve problems or challenges given by the teacher. Based on this, modifying various problems that will be related to mathematics is very important because, for a teacher who teaches mathematics, it is very important to be able to communicate mathematics not only for the teacher but also for students (Lanani, 2013). After students learn mathematics, students will experience changes, these changes are called learning outcomes

Learning outcomes are the culmination of the learning process (Suhendri, 2011). A potential that a student gets after they go through the learning process at school is a learning outcome (Susanto, 2019). (Kunandar, 2017) also assumes that learning outcomes are related to three abilities or changes in a student after going through learning activities, the three abilities in question are intellectual abilities, attitudes accompanied by skills. Changes caused by growth are not considered learning outcomes (Lestari, 2015). Based on this explanation, it can be concluded that the results of learning mathematics are children's competence in three aspects intellectual, attitudes, and skills, especially those related to the rational thinking process in obtaining concepts and in solving various problems after the mathematics learning process takes place. Based on this, after mathematics learning activities take place, students are expected to understand the benefits of mathematics.

But various problems make students do not understand what is the benefit of learning mathematics and how to apply mathematics in everyday life, this is what triggers low student learning outcomes (Kesumawati, 2008) this is supported by observations conducted, 171 out of 243 students whose mathematics UTS score was still less than the KKM with the KKM 75. Based on these data, 29.7% of the students scored had fulfilled the KKM while 70.3% of the students scored still less than the KKM. This percentage obtained based on student UTS learning outcomes data sourced from the teacher. 70.3% is not a small percentage and cannot be taken lightly. This high percentage is certainly a serious problem. In addition to the results of observations, the results of interviews with the teacher of fifth-grade elementary school also reinforce the problem that occurs, the low score of students in mathematics lessons caused because when answering UTS questions in the form of description questions, students do not describe the method of solving problems in essay questions and many students answered incorrectly, so the scores obtained by the students was small. The reason students do not include the method/solution of the description questions is because they do not understand the concept of the problem when it is related to mathematics material and the tendency of the teacher to provide more evaluation questions in the form of multiple-choice questions so that students are accustomed to answering briefly even students are accustomed to answering randomly. It is based on the interview result with some of the related students. If it is allowed to continue, it will have an impact on learning outcomes and student grades, and the knowledge that students have, it is very necessary to do innovation in the learning process to suppress the problems that have been previously described. Of course, these innovations are expected to have a positive impact both for teachers and for students in schools. The use of various learning models is one form of innovation in learning. But in selecting the model, of course, it must be adjusted to the conditions, material, and objectives of the learning. Because the problem in this study is related to learning outcomes and problem-solving by students, the relevant model is applied to overcome the problems that occur is the Problem Based instruction model. In theory, the Problem Based Instruction Model is a learning model that refers to a problem where the problem is closely related to the life around students (Trianto, 2015). (Komalasari, 2017) also considers that Problem Based Instruction is not much related to everyday life where problems or problems are the main

point. Thus this model is very relevant because it is following the problems that occur, the Problem Based Instruction Model, if applied in the learning process, it must go through several stages, (1) orientation (2) organizing (3) investigation (4) showing the work result (5) evaluation (Trianto, 2014). This model also has advantages, realistic, according to student needs, fostering inquiry, strong student concepts, and fostering student problem-solving skills with several syntax that builds this model, starting from orientation, organizing, investigating, displaying results of the work, and evaluating (Trianto, 2015). Some of the advantages of the Problem Based Instruction model are the reasons for testing this model in learning because it is considered relevant to the problems that are happening. And by testing the Problem Based Instruction model, it will certainly help improve student learning outcomes and student understanding of mathematics material. This is also reinforced by several relevant research results, research from (Puspiatasari et al., 2014) and (Hariata et al., 2017) which states that the Problem Based Instruction model affects student learning outcomes. The difference between this study and research conducted by (Puspiatasari et al., 2014) and (Hariata et al., 2017) is that it lies in the dependent variable, if in this study the dependent variable is the result of learning mathematics while in the study (Puspiatasari et al., 2014) and (Hariata et al., 2017) the dependent variable is social studies learning outcomes. Besides there are differences, there are also similarities, both applying the Problem Based Instruction model as independent variables. This is what strongly supports this research, reinforced by research results from (Puspiatasari et al., 2014) and (Hariata et al., 2017). Apart from the two relevant studies, research from (Darmana, Sedanayasa, & Madri Antari, 2013). (Darmana et al., 2013), (Mayanti, 2015), (Hadi & Vidarma Susanti, 2017), (Ita & Listyaningsih, 2014) research from (Hakim, 2012) is also very supportive of this research because from the results of this relevant study it is concluded that the Problem Based Instruction model affects the dependent variable in each study.

Some of the relevant studies that have been described in general have the same objectives as this study, to determine the effect of the Problem Based Instruction model. But there are differences from these objectives, the difference lies in each dependent variable. All dependent variables in the relevant research are certainly different from this study. But even though there are differences, there are also similarities between this study and the relevant research, both applying and testing the Problem Based Instruction model as an independent variable in learning.

2. Research Method

This research is a quasi-experimental study using a non-equivalent control group design (Sugiyono, 2015) which in its implementation the pretest is only used to determine group equality while what is analyzed as learning outcome data is the posttest. The cluster technique was chosen to select samples until two research samples were selected as the experimental group and control group.

The data collection method in this study used the test method because it will analyze student learning outcomes. Essay test choose as the method of collecting data with a total of 13 items. The items are equipped with a grid to determine the relationship between the indicators and the items. The grid designed to measure students' mathematics learning outcomes refers to thinking abilities, C3, and C4 in Anderson's revised Bloom's taxonomy. The item grid is equipped with basic competencies, indicators, types of questions, and level of difficulty. The grid and 13 items consulted with the related homeroom teacher.

After being approved and deemed following the material, the 13 item descriptions that were polyatomic were tested for validity with product-moment correlation, and their reliability was tested with the Cronbach alpha formula (Pramana & Putra, 2019), so that 12 items were valid and classified as reliable with a level of reliability. that is 1.0. Testing the validity and reliability of the questions was assisted by the Microsoft Excel 2007 program. The scoring technique on the test items used the point method technique, which was comparing students' answers to the answer keys (Sukarni, 2010). The answer key that has been made is designed in such a way that each answer or completion criterion gets a certain weight (score). The following is a grid of posttest questions after the validity and reliability tests.

Table 1. Posttest Grid

Basic Competencies	Indicator	Type of question	Difficulty level					
			C1	C2	C3	C4	C5	C6
3.5 Explaining and Determining the volume of a space using volume units (such as unit cubes) and the cube relationship with the cube root	3.5.1 Understand the elements of a cubic space	Description			10			
	3.5.2 Understanding the elements of a block structure	Description			3			
	3.5.3. Calculate the cube	Description			11			
	3.5.4 Calculating cube root number	Description			12			
	3.5.5 Calculate the volume of a cubic shape	Description				6		
	3.5.6. Calculate the volume of the block space	Description				7		
4.5. solve problems related to the volume of a spatial using volume units (such as unit cubes) involving the cube of three and the cube root	4.5.1 Solve problems related to space cubes using unit cubes	Description				1		
	4.5.2. Solve problems related to block numbers using unit cubes	Description				2		
	4.5.3. Solve problems related to cube numbers	Description			4			
	4.5.4. Solve problems related to cube root numbers	Description			5			
	4.5.5. Solve problems related to the volume of a cuboid	Description				8		
	4.5.6. Solving problems related to the volume of the block space	Description				9		

After obtaining the mathematics learning outcomes data, the learning outcome data are then analyzed using the inferential statistical analysis method because the research results obtained in the sample will be generalized to the population (Sholikhah, 2016). The statistical analysis used in this study was the t-test with the separated variance formula. Two conditions are passed before the t-test, the normality test of the data distribution using the chi-square test and the homogeneity test of variance using the Fisher test. In the calculation of data normality test, homogeneity test of variance and t-test, and data processing analysis of student mathematics learning outcomes assisted by the Microsoft Excel 2007 program.

3. Result and Discussion

The results of this study were obtained from the data on student mathematics learning outcomes in the sample. Mathematics learning outcomes are objects that become the dependent

variable in this study. Two things become the focus of this research: 1) differences in the results of learning mathematics for groups that are taught using the problem-based instruction model with those that are taught conventionally. 2) the effect of the problem-based instruction model on the mathematics learning outcomes of fifth-grade elementary school students. After the posttest instrument was distributed to each sample, then the data on the students' mathematics learning outcomes were summarized. The summary of student learning outcomes data is presented in Table 2.

Table 2. Description of Mathematics Learning Outcomes Data (Posttest)

Analysis result	Experiment	Control
Mean	85,7790	66,8636
Median	88,9737	66,3333
Mode	91,1667	64,7857
Variance	82,2060	212,0507
Deviation Standard	9,0668	14,3955
Minimum score	61	36
Maximum score	100	100

Based on Table 2, especially in experimental group data, it can be described that the maximum score by students is 100 while the lowest score is 61 and the mean score is 85.7791, which means that the student's score tends to be around 85.7791 as the central tendency, Meanwhile, the median is 88.9737, which means that the middle value of student learning outcomes data is 88.9737. Then the mode is 91.1667, which means the score with the maximum frequency is 91.1667. Meanwhile, the variance score and standard deviation obtained if the standard deviation is compared with the mean, then the standard deviation is <mean or 9.067 <85.78, it can be described that the mean score can be represented the entire data. Furthermore, the data in the control group will be described.

Based on Table 2, especially in control group data, it can be described that the maximum score is 100, while the lowest score is 36 and the mean score is 66.8636 which means that the student's score tends to be around 66.8636 as the central tendency, Meanwhile, the median is 66.3333, which means that the middle score of the student learning outcomes is 66.3333. Then mode is 64.7857, which means the score with the maximum frequency is 64.7857. Meanwhile, the variance score and standard deviation obtained if the standard deviation is compared with the mean, then the standard deviation is <mean or 14.3955 <66.8636, it can be described that the mean score can be represented the entire data.

After the data on student learning outcomes were described, the mathematics learning outcomes data were analyzed using the t-test with the separated variance formula. But before that, the data on the results of learning mathematics were tested for normality using the chi-square test, meanwhile, for testing the homogeneity used the Fisher test. The analysis of the normality test and homogeneity test assisted by Microsoft Excel 2007. The results for the normality and homogeneity test of data can be seen in Table 3 below.

Table 3. Recapitulation of Normality Test and Homogeneity Test of Learning Outcomes (Posttest)

No	Group	Result		Status	F_{hitung}	F_{tabel}	Status
		X^2_{hitung}	X^2_{tabel}				
1	Experiment	10,3549	11,07	Normal	2,5795	1,66	Inhomogeneous
2	Control	0,9848	11,07	Normal			

Data can be said to be normal if the calculated x2 score is less than x2 table. Referring to Table 3., it is obtained Chi-Square count in the experimental group (x2hit = 10.3549) while in the control group (x2hit = 1.0164) after knowing x2hit it is compared with x2tab with degrees of freedom (dk) = 5 at the significance level of 5 % ie 11.07 in each group. The comparison results show that the x2hit in both groups is less than x2tab or x2hit <x2tab, therefore the data in both samples are normally distributed. After the data is normally distributed, it is followed by the homogeneity test.

Data can be said to be homogeneous if the score of F_{count} is less than F_{table}. Based on the data in Table 3, it is obtained that F_{count} is more than F_{table}, F_{count} = 2.5795. F_{count} is then compared with F_{table} = 1.66 with dk numerator = 42 and dk denominator = 43 at the 5% significance level. Based on the established criteria, it is obtained $F_{count} > F_{table}$ so that the learning outcome data (posttest) in the sample can be said to be not homogeneous. Therefore, the separated variance formula is used to determine whether there is a significant difference between student learning outcomes taught by the Problem Based Instruction model and the group taught conventionally. The following results of the analysis using the separated variance formula are presented in Table 4.

Table 4. Recapitulation of t-test Learning Outcome Data (Posttest)

No	Group	Mean	t_{hitung}	t_{tabel}	Status
1	Experiment	85,7791	2,021	7,2909	$t_{hitung} > t_{tabel}$
2	Control	212,0507			

Based on Table 4 the Recapitulation of the t-test for learning outcomes (posttest), 7,2909 as t_{hit}. Meanwhile, 2.021 as t_{tab} with a substitute for t table is calculated from the difference between t table with dk = n1 - 1 and dk = n2 - 1 divided by two and then added by the smallest t. Testing based on the five percent significance level. Therefore, it can be concluded that there is rejection of H0 and acceptance of Ha because $t_{hit} > t_{tab}$ is 7,2909> 2,021 with H0 and Ha as follows

H_0 : There was no difference in mathematics learning outcomes between the groups that were taught through the problem-based instruction model and those that were taught conventionally

H_a : There are differences in mathematics learning outcomes between groups that are taught through the problem-based instruction model and those that are taught conventionally

Many problems were found when the observation was made but the main problem refers to student learning outcomes which are closely related to the process of problem-solving that is usually found in essay questions so that this becomes the focus of research. After the research was carried out, a result was obtained, that the learning outcomes of the group that were taught using the Problem Based Instruction model were different from the learning outcomes of groups that were taught conventionally. It can be seen based on the results of the data analysis, 85.7790 as the experimental group learning meanwhile 66.8636 as the average learning outcomes of the control group. If the two gains are compared, the mean gain for the experimental group is maximized.

Furthermore, through the separated formula, 7,2909 were obtained as t_{hit} while 2,021 were obtained as t_{tab}. Therefore, H0 is rejected and Ha is accepted. Based on the results of the analysis, it was found that the Problem Based Instruction model had a positive effect on the mathematics learning outcomes of fifth-grade students. This is because the application of the Problem Based Instruction model to the experimental group makes students more serious and focused. In delivering material, it is always related to problems around students. Students find it easier to imagine these problems and of course the benefits of this learning will be felt by the students themselves. It is very easy for a student to understand a problem in everyday life as well as a problem given by the teacher at school or a problem in the form of a test, both multiple-choice and essay types. Thus, the model applied has a very positive impact on teachers and students because they mutually benefit, especially for students. Students directly seek and understand the material in problem-solving. Students themselves solve together with their respective groups. Meanwhile, the teacher's task becomes more flexible and easier in terms of monitoring the development of student knowledge because in the implementation of this model the teacher's task is only as a facilitator while the students are active (student center).

This finding is of course very consistent with several theoretical concepts related to the Problem Based Instruction model. Problem Based Instruction is a learning model that refers to problems where the problem is closely related to the life around students (Trianto, 2015). (Komalasari, 2017) also believes that the Problem Based Instruction model is never separated from everyday problems. The steps in this model are very suitable for meaningful learning because this model emphasizes students' skills in solving problems both independently and in groups with their friends. The implementation of these model students fully contributes to learning, while the teacher is only a facilitator who always helps students when they encounter difficulties, not spoiling students

when learning. This model certainly has several advantages. The advantages of this model support student learning outcomes to be better, especially in mastering learning concepts, especially in understanding the concept of essay questions that require quite complex solutions. The advantages of this model (1) Realistic and always related to problems that students may have experienced. (2) Learning is following whatever the needs of the student (3) Making students accustomed to finding out all things (inquiries) (4) Strong reference concepts (5) Getting students to have problem-solving skills, (Trianto, 2015).

Apart from the theories from book sources as well as the facts that occur in the research location, the results of this study are also supported by several other research results. (Hariata et al., 2017), (Mayanti, 2015) and (Puspiatasari et al., 2014) which state that Problem Based Instruction affects student social studies learning outcomes. There are similarities between research from (Hariata et al., 2017), (Mayanti, 2015) and (Puspiatasari et al., 2014). This study uses the application of Problem Based Instruction as an independent variable. This is what supports this research. Besides the similarities, some differences differentiate this research. The difference is in the dependent variable. If in this study mathematics learning outcomes are the dependent variable while social studies learning outcomes are the dependent variable in the study (Puspiatasari et al., 2014), (Mayanti, 2015) and (Hariata et al., 2017). Apart from the two relevant studies, research from (Darmana et al., 2013), which states that the Problem Based Instruction model affects problem-solving abilities in mathematics also supports this study because they both use the independent variable Problem Based Instruction. What distinguishes is the dependent variable between this study and research from (Darmana et al., 2013) with the dependent variable, the problem-solving ability of mathematics learning. In this study, the dependent variable is learning outcomes. Although there are differences between this study and research (Darmana et al., 2013), both research in mathematics learning which is of course very relevant and supports the results of this study. Furthermore, research from (Hadi & Vidarma Susanti, 2017), and (Hakim, 2012) also supports this research because of the results of research (Hadi & Vidarma Susanti, 2017) and (Hakim, 2012) state that Problem Based Instruction affects the dependent variable. respectively, the learning outcomes of the digestive system material in the study (Hadi & Vidarma Susanti, 2017). Biology learning outcomes are the dependent variable of the study (Hakim, 2012). This dependent variable is what distinguishes this research and research from (Hadi & Vidarma Susanti, 2017), and (Hakim, 2012). But even though it is different, there is a similarity between this research and research (Hadi & Vidarma Susanti, 2017), and (Hakim, 2012) both use the Problem Based Instruction model as independent variables. This equation supports the results of this study. Research from (Ita & Listyaningsih, 2014) also strongly supports this study because the results of this study state that Problem Based Instruction affects increasing students' critical thinking skills. The application of Problem Based Instruction as an independent variable is what this research has in common with research conducted by (Ita & Listyaningsih, 2014). What distinguishes this research from (Ita & Listyaningsih, 2014) lies in the dependent variable, student mathematics learning outcomes which are the dependent variable of this study. Increasing students' critical thinking skills is the dependent variable in the study (Ita & Listyaningsih, 2014).

Based on several studies of relevant research results that have been previously described. The seven studies strongly support this research. From the relevant research results, it is concluded that Problem Based Instruction affects the dependent variable in each study. From the dependent variable in each of the relevant studies, several studies refer to mathematics learning. This certainly proves that Problem Based Instruction is good at giving a positive impact if it is applied to the learning process, especially mathematics learning in schools. This is due to several advantages of Problem Based Instruction (1) Realistic and always related to problems that students may have experienced. (2) Learning is very suitable for any student's needs (3) Making students accustomed to finding out all things (inquiries) (4) Strong reference concepts (5) Getting students to have problem-solving skills, (Trianto, 2015)

4. Conclusion

Based 0n the results of the hypothesis test, $t_{count} > t_{table}$ (7.2909> 2.021) which means that H0 is rejected and Ha is accepted with the average learning outcomes in the experimental group which is 85.7790 and the average learning outcomes in the group control 66.8636. It can be concluded that there is an effect of the Problem Based Instruction model on the results of fifth-grade mathematics learning at Elementary School in Gugus Jenderal Sudirman Denpasar Selatan for the 2019/2020

academic year. Based on the results obtained, it is suggested that every teacher should never be afraid to give the broadest opportunity for students to develop their potential, especially in terms of problem-solving. It is hoped that through this research, the principal will always coordinate with related teachers regarding the learning model which will certainly make students feel more meaningful learning. For future researchers, the results of this study are used as a reference in the implementation of research that will be carried out further, of course with more various modifications.

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