

# Preparation Development Of Learning Device Problem Based Learning Model With Scientific Approach To Improve Mathematical Problem Solving Ability

Neilur Rahmi, I Made Arnawa, Yerizon

**Abstract**— The problem in this study is the students' mathematical problem solving ability is still low, the cause is that the learning device designed by the teacher has not supported the formation of these abilities. Through learning device development will improve students' mathematical problem solving. This is a development research with Plomp model. The Statistic Group Comparison Design is the experimental design being used in this research. Research result reveals that: (1) Learning device developed by the researcher is 3.55 in average resulted from validation result by experts and it is a very valid category. (2) On average both teacher and students respond toward learning device based on Problem Based Learning as a whole is valid with 80.675% average percentage and in including in a good or practical respond criteria. (3) Students learning result reveals sig. score (2-tailed) 0.014 smaller than  $\alpha$  (0.05) score, hence  $H_0$  is rejected and  $H_1$  is accepted. Conclusions obtained that learning device based on Problem Based Learning with a scientific approach has a significant impact toward class VIII students of Islamic Junior High School (MTs) ability in solving mathematics problem.

**Index Terms**— Problem Based Learning Model, Scientific Approach and Mathematical Problem Solving Ability.

## 1 INTRODUCTION

Skills in solving problems are the ultimate goal of mathematics learning. This is also stated in Permendiknas No. 22 of 2006, namely that students can solve mathematical problems namely having problem solving skills, designing mathematical models, completing the model and interpreting the solutions obtained [1].

Mathematical problem solving ability is the ability of students to use mathematics in their daily lives [2] [3]. This ability can also be applied in the field of field studies other than mathematics [4]. Problem solving is the process used to solve problems [5]. Therefore students need to understand and master mathematics so that various competencies are expected to be achieved well and optimally. Hence, students need to understand and master mathematics in order to achieve a well and optimal competences.

In fact, students' ability of mathematics problem solving is still low. Many research such as conducted by Cut Yuniza Eviyanti [6], Sandro J. Simamora [7], K. Darma [8] also state the same result that students ability in solving mathematics problem is low.

This is supported by the observation result conduct by researcher in Public Islamic Junior High School (MTsN) 1 and Public Islamic Junior High School (MTsN) 2 Bukittinggi. It is known that numerous students are not able yet to solve mathematics problem related with daily life. Researchers provide 2 mathematical problems about cartecius coordinate system. Researchers then ask some students during the test, their answers reveal that they are not used to work on this kind of question. The main factor which causes the low ability of the students to solve mathematics problem is the learning that has conducted are not yet able to develop students' problem solving ability. Some students look confuse on how to work on that kind of questions. The analysis result shows that students' ability solving mathematics problem is under the average, as can be seen in Table 1 as follow:

TABLE 1  
THE AVERAGE SCORE OF STUDENTS' MATHEMATICAL PROBLEM SOLVING ON CARTECIUS COORDINATE MATERIAL:

Indicator	Average
1. Identify data adequacy for problem solving	3,40
2. Plan the solving or choose the strategy	3,01
3. Choose and implement strategy to solve the problem	2,77
4. Explain or interpret result based on the original problem, and check the correctness of the answer.	2,46
Total Score	11,65
Average score of problem solving ability	72,86

KKM (Minimum Completeness Criteria): 75

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One of the reasons to the low success of learning is the less optimal of learning device planning. It is due to the achievement of mathematics learning cannot be separated from the used learning device. [9]. The used learning devices are worksheet (LKPD) and Lesson Plan (RPP). The interview result as conducted by the researcher to teacher in MTsN revealed that learning model in the lesson plan is conventional or direct learning, where teacher delivers learning material in front of class and students sit still while listening teacher explanation without feedback. Next, in the core activity of the learning, teacher did not provide any questions for students, but provides only concept material. As the effect, students are not used to work on that kind of question. In addition, teachers do not design their own LKPD and students also do not have LKPD which can help to support their ability to solve problem.

Based on the above problem, it is important to have a learning model that can be a basic in developing RPP and LKPD. RPP and LKPD can be more improved by relying on one of the learning models which purpose is to improve students' ability in problem solving and teach them the way to solve problem. One of the learning models used to achieve the purpose is Problem Based Learning (PBL) [10].

PBL was sparked by Dewey (1938) in the field of medical education at McMaster University. There, students are taught content and clinical reasoning by identifying symptoms, making diagnoses, etc. then other fields that use PBL are advertising, architecture, engineering, nursing. They have found this PBL as an effective means [11].

PBL is a learning model that use real world problem as a context for the students to enable them to learn to think critically and to teach them the ability to solve problem, as to allow them to obtain essential knowledge and concept of the learning material [12]. The goals of PBL are to help the students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation [13]. Teacher role in developing PBL is not only to stand up in front of class and provide the students with the ready steps of problem solving but teacher plays role a facilitator in discussion, asking question, and help students to be aware on the importance of the learning. PBL also require teacher to be creative in the learning process so that students would be challenged and motivated in solving the problem. [14].

The application of this PBL model is carried out with a scientific approach. The scientific approach is the steps of learning following scientific rules in the form of steps in acquiring knowledge, namely observing, seeking, gathering information, associating and concluding [15].

For this reason, a research on the Development of Learning Device with PBL Model to improve mathematical problem solving ability of class VIII students.

Based on the background above, the research problems are as follow: (1) how is the characteristics a valid and practical

learning device based on PBL with scientific approach for class VIII students of Islamic Junior High School (MTs)? (2) How is the effectiveness of a valid and practical learning device based on PBL with scientific approach toward class VIII students of Islamic Junior High School (MTs) in solving mathematical problem?

The purposes of this research is: (1) To produce a valid and practical learning device based on PBL with scientific approach for class VIII students of Islamic Junior High School (MTs). (2) To see the effectiveness of learning device based on PBL with scientific approach toward class VIII students of Islamic Junior High School (MTs) ability in solving problem.

## 2. METHODS

This is a development research. Development research is a research used to produce particular product and to test the effectiveness of the product itself [16]. Development model employed is Plomp Model. Plomp (Plomp & Nieveen, 2013:30) divides development phases into three, namely, preliminary research, design phase and development and prototyping phase, and assessment phase [17] [3] [18] [19].

Data collection in this research is through validation sheet distributed to expert lecturer and mathematics teacher of class VIII Public Islamic Junior High School (MTsN) 1 Bukittinggi, validation sheet, student respond questionnaire, and final test for student.

Then in determining the validity of the learning device using the formula [20]:

$$R = \frac{\sum_{j=1}^m \bar{x}_j}{m}$$

Information:

$R$  = Validity of learning devices

$\bar{x}_j$  = Average results of the j-item evaluation

$m$  = many items

The criteria for obtaining the validity level of learning devices use criteria as in Table 2. Following:

TABLE 2  
CRITERIA FOR VALIDITY OF LEARNING DEVICES  
AVERAGE CRITERIA

Average	Criteria
$R > 3,20$	Very Valid
$2,40 < R \leq 3,20$	Valid
$1,60 < R \leq 2,40$	Fairly Valid
$0,80 < R \leq 1,60$	Less Valid
$R \leq 0,80$	Invalid

Source: Muliyardi [21]

Learning tools that will be tested are said to be valid and very valid, if the validity criteria used in this study are valid or very valid with  $R > 2.40$ .

The practicality of learning devices is described by data frequency analysis techniques with the formula proposed by Purwanto [22] below:

$$P = \frac{R}{SM} \times 100\%$$

Information:

P: Practical Value

R: Score obtained

SM: Maximum score

The practicality category of learning devices is determined by the achievement level criteria in Table 3 below:

TABLE 3  
PRACTICAL CATEGORIES OF LEARNING DEVICES

Practical Value (%)	Criteria
$85 \leq P \leq 100$	Very Practical
$75 \leq P < 85$	Practical
$60 \leq P < 75$	Pretty Practical
$55 \leq P < 60$	Less Practical
$0 \leq P < 55$	Very Less Practical

Source: Purwanto [23]

Learning devices that are tested are said to be practical and very practical with criteria of 75% to 100%.

The effectiveness of learning devices is seen from the results of the final test in the form of problem solving questions that have been assessed based on the problem solving rubric. Then continue using the formula:

TABLE 4  
ASSESSMENT CRITERIA FOR EFFECTIVENESS

Range of Category (%)	Category
0-20	Very Less Effective
21-40	Ineffective
41-60	is quite effective
61-80	Effective
81-100	Very effective

Source: Modified from Eko Putro Widoyoko [23]

Learning devices are said to be effective if the number of students who achieve completeness is greater or equal to 61%. The design of research experiment used on learning result is the Static-Group Comparison. The research design can be described as follow:

TABLE 5  
THE STATIC-GROUP COMPARISON

Classes	Treatment	Post-Test
Experiment	X <sub>1</sub>	O <sub>1</sub>
Control	X <sub>2</sub>	O <sub>2</sub>

Appendix:

X<sub>1</sub> = PBL model treatment

X<sub>2</sub> = Direct learning model treatment

O<sub>1</sub> = Post-test result in experiment class

O<sub>2</sub> = Post-test result in control class

Steps in statistics test are as follow: (1) formulate hypothesis,

(2) normality test, (3) homogeneity test, (4) hypothesis test. Statistics test in this research employs version 23 of SPSS software.

Hypothesis test employs t-test one sample. This one sample t-test is aimed to reveal whether the influence of PBL is better than Direct Learning Model. T-test is conducted by using version 23 of SPSS. Data in this research is two independent samples. Statistics employs independent sample T-Test. Independent t-test is to test the difference between two independent groups (to test two classes, experiment and control classes). The criterion of the test is if sig. score (2-tailed) is smaller than 0.05, hence  $H_0$  is rejected and  $H_1$  is accepted.

### 3. RESULT AND DISCUSSION

On the development and the prototype making process, some experts conduct design and validation processes. The prototype making stage initiated by designing LKPD based on PBL. The result of the design is called as prototype 1. Self evaluation takes place after producing LKPD based on PBL.

On self evaluation stage, there found mistyping, imperfect sentence, and inappropriate punctuation. After revising on self evaluation, learning device will be handed over to the experts to do validation. The validated aspects on RPP are its component, learning activity, and language. Lesson Plan validation is conducted by 4 experts consist of 3 mathematics experts, and 1 language expert. The validation result of RPP by the experts can be seen on the following Table 6.

TABLE 6.  
THE RESULT OF VALIDATION ASSESSMENT OF RPP

Aspect	The Average Assessment Score				Average	Criteria
	V1	V2	V3	V4		
RPP component	3,1	4	3,4	-	3,52	Very Valid
Learning Activity	3	4	3,5	-	3,5	Very Valid
Language	3	4	3,5	3,5	3,75	Very Valid
Final Average					3,59	Very Valid

Table 6 shows that the result of validity test of RPP which designed by using learning model with PBL is valid according to the expert. The average assessment of each aspect is in very valid criteria, even though there is still improvement on RPP designed by the researcher. Validator suggests reorganizing the learning purpose appropriately. Hence, researcher revises the developed RPP, so that it can be used to help the process of learning activity. One of the revision examples of RPP before and after revision can be seen on the following Table 7.

TABLE 7.  
THE RESULT OF RPP REVISION  
AS SUGGESTED BY VALIDATOR

Before Revision	
1.	Students can observe geometry in the form of pyramid in their environment
2.	Through observation, students can identify the component of the geometry.
3.	After identifying, students can find and explain the width of the pyramid surface by using their own language.
4.	Solving the problem in real life in relation with pyramid.
After Revision	
1.	Through group discussion, students can find the correct width of pyramid surface.
2.	Through group discussion, students can solve the problem related with width of pyramid surface correctly.

LKPD is designed based on preliminary analysis conducted by researcher toward need analysis, student analysis, curriculum analysis, and concept analysis. LKPD based on PBL is designed in line with PBL. The designed students work sheet (LKPD) validated by 5 experts consists of 3 mathematics experts, 1 language expert and 1 education technology expert. The validated aspects on LKPD are presentation, appropriateness, content, graphic or display, and language. Validators assess the learning device after revision. The result of LKPD validation can be seen in the following Table 8.

TABLE 8.  
VALIDATION RESULT OF LKPD

Assessed Aspect	The Average Assessment Score					Average	Criteria
	V1	V2	V3	V4	V5		
Presentation	3,2	4	3	-	-	3,55	Very Valid
Content Appropriateness	3	4	4	-	-	3,51	Very Valid
Language	-	-	-	3,75	-	3,75	Very Valid
Graphics	-	-	-	-	3,5	3,5	Very Valid
Average						3,58	Very Valid

As a whole, LKPD based on PBL as validated by mathematics expert has fulfilled very valid criteria with 3.55 validity index on presentation aspect. Validation result implies that LKPD is in line with the targeted competence. The other aspect is content appropriateness on LKPD with 3.51 validity index.

The validity result implies the appropriateness between material and task.

The next one is language aspect with 3.75 validity index. The validity result implies that the use of sentence on LKPD is suitable with correct Indonesian language grammar, yet communicative. The last one is graphic aspect with 3.5 validity index. The validity result implies the characteristics and the suitability of LKPD with PBL model which can help students to improve their ability in solving mathematical problems. Finally, it can be concluded that LKPD with PBL is very valid according to the expert.

Validator suggests improving LKPD such as start with the easy one, and improving the difficulty on the next level gradually. One example of LKPD before and after the revision can be seen as follow on Table 9.

TABLE 9.  
RESULT OF LKPD REVISION AS SUGGESTED BY  
VALIDATOR

Before/After Revision	
Before revision :	
Problem 1	Let's experiment
Mr. Ibnu will paint a cubical room with ceiling. The height of the wall is 3 m. 1 small can of paint is assumed to be able to paint the surface of the wall with 9m <sup>2</sup> width. The price of one small can of Avian paint is Rp. 16.000, 00. The floor also will be equipped with ceramic size 30 cm x 30 cm. The price of a dozen ceramic is Rp. 48.000,00. How much does it all cost Mr. Ibnu to buy paint and ceramic for the room?	
After Revision	
Problem 1	Let's experiment
Lathifah was asked by her teacher to make a cuboids tissue box made of paperboard with 15cm rib size. Determine the width of the paperboard used by Lathifah?	
Question validation of final test is conducted by 2 mathematics experts. The validation result can be seen in the following Table 10:	

TABLE 10  
VALIDATION RESULT OF PROBLEM SOLVING FINAL TEST

Aspect	V1	V2
<b>Question appropriateness</b>		
Question formulation is in accordance with the learning material	4	4
Question formulation is including problem solving indicator	4	4
<b>Language component</b>		
Question formulation is easy to read and to comprehend	3	3
Question formulation used language in accordance with appropriate language rules	4	3
Question formulation do not use sentence which can cause ambiguity	3	3
<b>Presentation Component</b>		
Question sheet has a complete identity	4	3
Question sheet has a clear guidance	4	3
Question formulation is arranged systematically	4	3
<b>Average</b>	<b>3,75</b>	<b>3,25</b>
<b>Final Average</b>	<b>3,5</b>	
<b>Information</b>	<b>Valid</b>	

Based on final average, hence question of problem solving can be used in final test. However, there still is revision from the experts, one of the revisions is the question should be more about real life, so that student has more opportunity to deal with the question. Question revision can be seen in this following Table 11.

TABLE 11.  
REVISION OF FINAL TEST QUESTION

Before revision
Angga will make an aquarium in a cube form. The height is 70 cm. Determine the width of the glass needed! If the aquarium is full with 60 cm water, how many liter is water in the aquarium? (Please note that the aquarium is a cube without cover!)

#### After revision

Angga is a good kid and love to take care of fish. For those reason, Angga has a fish pond with variety fish. One day, Angga went to Pasar Aur and found a merchant who sold little cute golden fishes and Angga wanted to purchased them. However, those little fishes cannot stay in one pond with bigger fishes. Hence, Angga needs a small aquarium for those little fishes. Since those little fishes are in small number, so Angga only need a small size aquarium. The problem is Angga couldn't find the small size aquarium in the market. He need a 70 cm x 70 cm x 70 cm aquarium size. Therefore, Angga decide to make his own small size aquarium. Help Angga to calculate the size of aquarium glass that he need to buy for his little golden fishes. (Please note that the aquarium is without cover!)

The average result of learning device validity can be seen in Table 12:

TABLE 12  
THE AVERAGE OF INSTRUMENT VALIDATION RESULT

No	Instrument	Result	Criteria
1	RPP	3,59	Vey valid
2	LKPD	3,58	Very valid
3	Final Test	3,5	Very valid
Vinal Average		3,55	Very valid

The above table shows that learning device is in a very valid category and can be tested.

Data of device practicality is obtained from student's respond questionnaire result and teacher's respond. Both can be seen in Table 13:

TABLE 13.  
THE RESULT OF PRACTICALITY QUESTIONNAIRE

Questionnaire	Practical Category
Student's Respond	83,68 %
Teacher Respond	77,67 %
Vinal Average	80,675 %

Student's respond is obtained through the fulfillment of student respond questionnaire after learning process with PBL. The questionnaire was distributed toward students of class VIII.6 as an experiment class. The calculation result of student respond questionnaire toward PBL model is in practical category, 83.68%. Next, device practicality by teacher is 77.67 %. It is a practical category. Hence, final average of practicality toward device is 80.675% with practical category. Since the result of teacher respond and student respond is practical, therefore PBL model is appropriate to be used in the learning process in Islamic Public Junior High School (MTsN) 1 Bukittinggi. Next, the result of student learning test is

discussed by using hypothesis test with t test along with discussion. Table 14 presents statistical descriptive result of final test result:

TABLE 14.  
STATISTICS DESCRIPTION OF LEARNING RESULT EVALUATION

Classes	N	Mean	Std. Deviation	Max	Min
Control class	32	73,28	12,49	96,25	46,25
Experiment Class	37	80,06	9,71	95	57,50

Normality test employed in this research is Kolmogorov-Smirnov test (by using version 23 SPSS software). In this normality test,  $H_0$  will be tested with  $H_1$ , where in normality test  $H_0$  is population with normal distribution. Meanwhile,  $H_1$  is the comparison hypothesis which is a population with abnormal distribution. The result of normality calculation with Kolmogorov-Smirnov by using version 23 SPSS software will be presented in Table 15.

TABLE 15.  
NORMALITY TEST OF EXPERIMENT AND CONTROL CLASSES

Tests of Normality							
Classes	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk			Sig.
	Statistic	Df	Sig.	Statistic	Df	Sig.	
Control	,094	32	,200*	,971	32	,521	
Expe	,112	37	,200*	,952	37	,116	

\*. This is a lower bound of the true significance.  
a. Lilliefors Significance Correction

The above table shows the signification score of Kolmogorov-Smirnov test result in experiment class with p value = 0.112 meanwhile control class with p value = 0.094. The result in the table reveals that score data of post-test is in normal distribution. It can be concluded that  $H_0$  can be accepted since data of learning result of both experiment and control classes are in normal distribution due to its probability score is bigger than real standard 0.05. It is known that in normality test, population is in normal distribution and can be continued to conduct homogeneity test. Homogeneity test is conducted to reveal whether the two samples have the same variant. This research used Levene-Statistics test (by using version 23 SPSS which presented in Table 16).

TABLE 16.  
HOMOGENEITY TEST OF EXPERIMENT AND CONTROL CLASSES

Test of Homogeneity of Variances			
Value	Levene Statistic	df1	df2
	2,225	1	67
			Sig. ,140

Homogeneity test reveals that the two classes have the same variant. The sig. score of both classes is 0.140 and is bigger than the real standard 0.05. Moreover, once the data has normal and homogeny, hypothesis test by using t test took place. T test is calculated by using version 23 of SPSS. Data in this research is two independent samples. Statistics used is independent sample T-Test. Independent t test used to test the difference between two independent groups (to test two classes, experiment and control classes). One sample t test by using version 23 of SPSS with independent sample t test can be seen in Table 17:

TABLE 17.  
STATISTICS DATA OF STATISTICS GROUP

Group Statistics					
	Classes	N	Mean	Std. Deviation	Std. Error Mean
Value	Control	32	73,2813	12,49092	2,20810
	Expe.	37	80,0676	9,71354	1,59690

Statistics Group presents GPSS calculation result about amount of data, the average score, deviation standard, and the average error standard. Class VII.4 is a control class which uses direct learning model. Meanwhile, class VIII.6 is the experiment one which uses PBL model.

TABLE 18.  
ANALYSIS OF T TEST WITH SPSS 32

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
trial	Equal variances assumed	2,225	,140	-2,536	67	,014	-6,78632	2,67610	-12,12783	-1,44481
	Equal variances not assumed			-2,490	58,198	,016	-6,78632	2,72503	-12,24067	-1,33197

According to the above table, the analysis result of one way- t test shows that the sig. score (2-tailed) 0.014 smaller than  $\alpha$  score (0.05) hence  $H_0$  is rejected and  $H_1$  is accepted. Therefore, it can be concluded that learning device based on PBL with scientific approach has a significant influence toward the ability to solve mathematics problem of students of class VIII in Islamic Junior High School (MTs). This can be seen from the relationship between the PBL model and scientific approach to problem solving abilities as follows:

Through activities to observe and gather information in group discussions, students can identify the adequacy of data for problem solving. Students can write down what is known from the problem completely and correctly. Furthermore, through associating and questioning activities in PBL syntax guiding individuals / groups, students are able to determine what is asked in the problem. Then plan a solution or choose a strategy, where students are able to develop mathematical models that will be used in solving problems correctly and are able to choose and apply these strategies to solve problems correctly. Then through the activities of communicating in the syntax presenting the results of the discussion, students are able to explain and interpret the results according to the original problem both in the LKPD and in front of their friends. Furthermore, through evaluating the results of problem solving and checking the truth of the results or answers evaluated by the teacher, students can re-examine the results of solving the problems they have done correctly.

The following are the results of the recapitulation of the final test of the experimental class and the control class:

Through activities to observe and gather information in group discussions, students can identify the adequacy of data for problem solving. Students can write down what is known from the problem completely and correctly. Furthermore, through associating and questioning activities in PBL syntax guiding individuals / groups, students are able to determine what is asked in the problem. Then plan a solution or choose a strategy, where students are able to develop mathematical models that will be used in solving problems correctly and are able to choose and apply these strategies to solve problems correctly. Then through the activities of communicating in the syntax presenting the results of the discussion, students are able to explain and interpret the results according to the original problem both in the LKPD and in front of their friends. Furthermore, through evaluating the results of problem solving and checking the truth of the results or answers evaluated by the teacher, students can re-examine the results of solving the problems they have done correctly.

The following are the results of the recapitulation of the final test of the experimental class and the control class:

TABLE 19.  
AVERAGE RECAPITULATION OF EXPERIMENTAL CLASS  
AND CONTROL CLASS AVERAGES

No	Indicator	Experiment Class averages	Control Class averages
1	Identify data adequacy for problem solving	3,68	3,51
2	Plan the solving or choose the strategy	3,4	2,9
3	Choose and implement strategy to solve the problem	3,1	2,7
4	Explain or interpret result based on the original problem, and check the correctness of the answer.	2,71	2,53
	Vinal Average	3,20	2,93

Highest score = 4

It means that PBL model learning device with scientific approaches are effective in improving problem solving abilities of class VIII MTs Students. Previous researchers who also supported this were Anti Prodjosantoso [25] [2].

#### 4. CONCLUSION

The research result and discussion can be concluded as follow: (1) The development of learning device model based on PBL consists of RPP, LKPD, and final test question. Based on the validation result by the experts, the development of this learning device is appropriate to be used as learning device in MTsN 1 Bukittinggi, with average 3.55 in a very valid category, (2) The analysis result of practicality questionnaire calculation conducted by teacher and students toward learning device based on PBL has a positive respond and is in practical category with average 80.675%. Since the result of both teacher and students responds are in practical category, hence PBL model is appropriate to be used in the learning process in Islamic Public Junior High School (MTsN) 1 Bukittinggi, (3) The calculation result of post-test score shows that sig. score (2-tailed) 0.014 is smaller than  $\alpha$  score (0.05) hence  $H_0$  is rejected and  $H_1$  is accepted. Therefore, it can be concluded that learning device based on PBL with scientific approach has a significant influence toward the ability to solve mathematics problem of class VIII students in MTs. In the other words, it can be said that learning device based on PBL with scientific approach is effective in improving the ability to solve problem of class VII students in MTs.

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