LEARNING TOOL DEVELOPMENT WITH THE PROBLEM BASED LEARNING (PBL) MODEL-ORIENTED MATHEMATICAL CRITICAL THINKING ABILITY

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Abstract. This study aims to produce learning tools in the form of Learning Implementation Plans (RPP) and Student Worksheets (LKPD) with Problem Based Learning (PBL) oriented Mathematical Critical Thinking Ability which has been tested for validity. The type of research used is Development Research using a modified ADDIE development model, namely the Analysis, Design, Development, and Evaluation stages. Instruments and data collection techniques are in RPP and LKPD validation sheets by validating learning tools by 2 Mathematics Education Lecturers, FKIP UIR, and 2 Mathematics Subject Teachers. The data analysis technique used is data analysis of the validation results of learning devices using descriptive statistics. The results showed that the results of the RPP validity for each aspect were 84.13%, with a very valid validity level. Each validator was 84.84%, with a very valid validity level. In comparison, the LKPD validity results for each aspect were 84.59%, with a very valid validity level, and each validator is 84.42% with a very valid validity level. Based on the results of the development of these learning tools, a Learning Device with a Problem Based Learning (PBL) Model oriented to Mathematical Critical Thinking Skills on Quadrangular Material has been tested for validity.

Keywords: *Learning Devices, Problem Based Learning (PBL), Mathematical Critical Thinking*

1. INTRODUCTION

The rapid development of science and technology makes it easier for a person to obtain, select and process information in conditions that are always changing. one of the forums that function as a producer of high-quality human resources in education. Efforts to improve the quality of human resources are the most important part of improving the quality of education, both in terms of abilities, personality, and responsibilities as citizens.

Each student is encouraged to be able to develop his ability to think, one of which is the ability to think mathematically. Mathematics education is one of the subjects that has a very important role in the mathematical thinking process in every child. Mathematics subjects need to be taught to all students from elementary school to the high school level to provide students with logical, critical, and creative thinking skills [1]. That is, the ability to think critically is one of the abilities included in the learning objectives of mathematics to be achieved and is one of the abilities that can train the thinking power of every student.

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Based on the explanation above, mathematics really needs to be taught in schools to students. However, it cannot be denied that mathematics is still a subject that is considered difficult, boring, and often causes problems in students' learning process, especially in problem-solving mathematical critical thinking skills. The fact is that the results of the 2015 PISA test and evaluation showed that Indonesia was in position 62 out of 70 countries, and the results of the TIMSS study placed Indonesia at 45th out of 50 countries [2]. Based on the data from the PISA and TIMSS above, it can be concluded that Indonesian students' mathematical critical thinking ability is still relatively low and does not increase every year. This is because students still have difficulty solving problems that require students to think critically.

Another problem was also obtained from the results of the researcher's interview with the mathematics teacher at SMPN 5 Pekanbaru on March 2, 2020, information was obtained that when the teacher gave story-shaped questions with a critical thinking level, students had not been able to develop their critical thinking skills to the maximum so that the results of thinking skills were students' mathematical criticality is still very low.

Based on the problems above, it is necessary to find the right solution how to overcome these problems. One solution is to use a good and correct learning tool. Learning tools are a plan used by teachers in the teaching and learning process. A good learning process must be made with good preparation, without good preparation it will be difficult to produce good learning, so the teacher should arrange learning tools properly before starting the learning process [3].

In addition, we need a learning model that can train and develop students' mathematical critical thinking skills. One of the learning models that are thought to develop students' mathematical critical thinking skills is the Problem Based Learning (PBL) learning model. The PBL model is a learning model that invites students always to think critically, solve problems well, learn independently, and demand skills to participate in groups [4]. This is in line with research conducted by Nurlaeli et al. (2018), which concluded that the mathematical critical thinking ability of the group of students who were given the PBL model was higher than the group of students who were given the conventional learning model students who had a high AQ [2].

Therefore, the researchers developed a learning device with a problem-based learning (PBL) model oriented to mathematical critical thinking skills in quadrangular material for class VII SMP. The PBL model can improve students' mathematical critical thinking skills based on the description above. So it is hoped that the development of learning tools that use the PBL model in the learning process can develop students' mathematical critical thinking skills.

2. RESEARCH METHOD

The type of research conducted in this research is development research. In this study, learning tools were developed using the ADDIE development model (*Analysis* -

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Design - Development - Implementation - Evaluations). This research was originally planned at SMPN 5 Pekanbaru, but due to the COVID-19 outbreak, it has only reached the evaluation stage. The evaluation stage in question is the product validation stage that was developed which was carried out by four validators, namely two mathematics education lecturers, FKIP UIR, and two mathematics teachers. The time of this research was carried out from July 9, 2020, to August 8, 2020. In this study, the research objects were RPP and LKPD with a PBL model oriented to mathematical critical thinking skills on quadrangle material for class VII SMP.

The data collection technique in this study was non-test. The data obtained from the validation results of the device were analyzed using descriptive statistics. Descriptive statistics are statistics used to analyze data by describing the data that has been collected correctly according to what is obtained [5]. The technique used in analyzing the data is to calculate the average value for each validation data. In analyzing the level of validity descriptively, you can use the following formula [6]:

$$\mathrm{Va}_{1,2,3,4} = \frac{\mathrm{Tse}}{\mathrm{TSh}} \times 100\%$$

$$\mathrm{V} = \frac{\mathrm{Va}_1 + \mathrm{Va}_2 + \mathrm{Va}_3 + \mathrm{Va}_4}{4}$$

Description:
Va = Expert validator
Tse = Total empirical score (validation result from validator)
TSh = Maximum expected total score
V = Combined validity (average validity)
Va = Validity of members (1st member/2nd member/3rd member/4th member)

After the results of the average validity are known, then to determine the criteria for the level of validity, see the following table [7]:

Table 1. Criteria for Validity Level

No.	Validity Criteria	Validity Level
1.	81,00 % - 100,00 %	Very valid, or can be used without revision.
2.	61,00 % - 80,00 %	Valid, or usable but need minor revision.
3.	41,00 % - 60,00 %	Less valid, it is recommended not to use it because it needs major revision.
4.	21,00 % - 40,00 %	Invalid, or should not be used.
5.	00,00 % - 20,00 %	Totally invalid, should not be used.

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3. RESULTS AND DISCUSSION

Research Results

The results of the stages of the development model carried out in this study are as follows:

1.1 Analysis Stage Results

In this study, the analysis phase is a pre-planning process carried out using the need for learning tools. Researchers analyzed the curriculum used, namely the 2013 curriculum. Then the researchers chose a learning model that became a reference in implementing the learning process steps, namely the PBL model-oriented with mathematical critical thinking skills.

1.2 Design Stage Results

At the design stage, the researcher designed the concept of the developed learning device. The learning tools are in the form of lesson plans and LKPD following the 2013 curriculum, and each meeting is arranged four to 4 times using rectangular material. In addition, the researchers designed the necessary instruments in the form of RPP and LKPD validation sheets.

1.3 Development Stage Results

After the learning device is designed, realize the learning device's design by developing the device and making the assessment instrument. The purpose of the development stage is to produce a new product from the results of the development of the device.

1.4 Evaluations Stage Results

After the learning tools are developed, the validation of the learning tools is carried out. The average results of the validity of the lesson plans consist of the average results of the validity of each aspect as follows:

Table 2. Results of RPP Validity for each Aspect

Assessment Aspect	Learning Implementation Plan (RPP) (%)				Average (%)	Validity Level
	1	2	3	4		
RPP Components	Complete				-	Very Valid
Appropriateness Contents	86,25	86,25	86,25	86,25	86,25	Very Valid
Serving Eligibility	84,38	85,42	84,38	85,42	84,90	Very Valid
Language Eligibility	81,25	81,25	81,25	81,25	81,25	Very Valid
Average Total					**84,13**	**Very Valid**

Source: Data processed by researchers

Based on table 2, the RPP component aspect does not have an average because the assessment is only based on completeness, and the results are complete so that it meets the very valid level of validity. Meanwhile, the total average validity of the RPP for other assessment aspects is 84.13% and meets the very valid validity level, with the highest

average value of the assessment aspect being in the aspect of content feasibility. So for the RPP assessment, each aspect can be declared to meet the very valid criteria and only requires a few minor revisions. In addition, researchers conducted an analysis of the validity of the RPP for each validator and obtained the average value as follows:

Table 3. Results of RPP Validity for each Validator

Validator	Learning Implementation Plan (RPP) (%)				Average (%)	Validity Level
	1	2	3	4		
Va_1	100,00	100,00	100,00	100,00	100,00	Very Valid
Va_2	73,75	72,50	73,75	72,50	73,13	Valid
Va_3	91,25	91,25	91,25	91,25	91,25	Very Valid
Va_4	75,00	75,00	75,00	75,00	75,00	Valid
Average Total					**84,84**	**Very Valid**

Source: Data processed by researchers

Based on table 3, the total average validity of the RPP for each validator is 84.84%, with a very valid validity level, with the highest average value of the validator assessment being validator 1. Thus, for the RPP assessment, each validator can be declared to meet the **Very Valid** criteria and only require a few minor revisions. While the results of the average validity of the LKPD consist of the average results of the validity of each aspect are as follows:

Table 4. LKPD Validity Results for each Aspect

Assessment Aspect	Student Worksheet (LKPD) (%)				Average (%)	Validity Level
	1	2	3	4		
Appropriateness Contents	82,81	82,81	82,81	82,81	82,81	Very Valid
Serving Eligibility	82,64	82,64	82,64	82,64	82,64	Very Valid
Language Eligibility	79,17	79,17	79,17	79,17	79,17	Valid
Time	93,75	93,75	93,75	93,75	93,75	Very Valid
Average total					**84,59**	**Very Valid**

Source: Data processed by researchers

Based on table 4, the total average validity of the LKPD for each assessment aspect is 84.59%, with a very valid validity level, with the highest average value of the assessment aspect being the time aspect. Thus, for the LKPD assessment, each aspect can be declared to meet the Very Valid criteria and only requires a few minor revisions. In addition, researchers analyzed the validity of each validator's LKPD and obtained the average value as follows:

Table 5. Results of LKPD Validity for each Validator

Validator	Student Worksheet (LKPD) (%)				Average (%)	Validity Level
	1	2	3	4		
Va_1	100,00	100,00	100,00	100,00	100,00	Very Valid
Va_2	75,00	75,00	75,00	75,00	75,00	Valid
Va_3	80,47	80,47	80,47	80,47	80,47	Valid
Va_4	74,22	74,22	74,22	74,22	74,22	Valid

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Average total	**82,42**	**Very Valid**

Source: Data processed by researchers

Based on table 5, the total average validity of the LKPD for each validator is 84.42%, with a very valid validity level, with the highest average value of validator assessment being validator 1. Thus, for LKPD assessment, each validator can be declared to meet the Very Valid criteria and only require a few minor revisions.

Discussion

This research aims to develop and produce a new product that can meet the valid criteria. The resulting product is a mathematics learning tool in the form of lesson plans and LKPD using the PBL model oriented to mathematical critical thinking skills in the quadrangular material of class VII SMP. The learning tools developed have been tested for validity because the values obtained for each indicator are in accordance with the opinions of experts. This is following the opinion of Indriyani et al. (2016); Revita (2017); and BSNP (2008), which says that a learning device is said to be valid if it meets the existing indicators [8]–[10].

In the analysis stage, the researcher analyzes the curriculum used, namely the 2013 curriculum, and chooses a suitable learning model. Researchers chose the Problem Based Learning (PBL) model oriented to mathematical critical thinking skills. After that, the researcher conducted interviews with the seventh-grade mathematics teacher at SMPN 5 Pekanbaru and got the results of the interviews and the solutions to the problems. Then the researchers developed learning tools that are expected to be additional guidelines for teachers in the learning process and increase interest in learning in order to improve their mathematical critical thinking skills.

After conducting the analysis phase of the curriculum used and getting solutions to problems at school, the researcher continued the research to the design stage. At this stage, the researcher designed a learning device containing the material used, namely rectangular material using a Problem Based Learning (PBL) model following the scientific approach, and included indicators of mathematical critical thinking skills used in the questions in the learning device.

After the learning device is designed, it is continued to the development phase of the learning device to realize the design that has been designed and to make an assessment instrument for the learning device. Learning tools developed in the form of lesson plans and LKPD using the PBL model oriented to mathematical critical thinking skills.

The next stage is the evaluation stage. At this stage, the resulting learning device is validated by the validator by going through the revision stage first based on suggestions and directions, then filling out the learning device validation sheet by the validator. The validators consisted of 2 lecturers of mathematics education lecturers at FKIP UIR and two mathematics teachers. After getting the data from the validation results, then the next step is to analyze the data from the validation results to find out the results of the product

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analysis that has been developed. Then obtained the final product of the development of learning devices that have been tested for validity.

4. CONCLUSION

Based on the results of the research and discussion that has been explained, it can be concluded that the final product produced in this study is a learning device that uses a Problem Based Learning (PBL) model oriented to mathematical critical thinking skills that meet the very valid validity level. Therefore, the resulting product is feasible and can be used in the learning process and assist teachers and students in carrying out the good and correct implementation of the learning process.

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