

# Development of Instrument Test on Mathematical Literature Learning in Elementary School

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## Abstract

This study aims to develop a valid and reliable test instrument to measure students' mathematical literacy in elementary schools. The type of research used is research and development that refers to the theory of Tessmer. The population in this study were students of class V elementary school in Metro. The sampling technique uses cluster technique. The sample of this research is class V students who amounted to 62 in Muhammadiyah Elementary School and Elementary School of 7<sup>th</sup> Metro. Data were collected through questionnaires and test questions. The results showed that the instrument of mathematics literacy test developed has qualify the criteria of writing questions rules, valid and realiable to measure students' mathematical literacy.

**Keywords:** Instrument test; mathematical literacy; Elementary School

## 1. Introduction

Education is the forerunner to the establishment of superior human resources to be able to survive in the rapid development of the world. Moreover, the development of the era that has entered the 21st century can not be separated from the development of science and technology is so rapid. According to Darmadi (2010, p. 235) to advance science and technology required an understanding of the science of mathematics strong early on.

Mathematics in the world of education is a subject in which have concepts related to each other so that learners are required to develop ways of thinking and use it to solve various problems in life. Burns (2007, p.8) states the goals of mathematics instruction today are clear—develop children's ability to think and reason mathematically and help them learn the concepts and skills they need to do so, skills in all of the content areas of mathematics to a range of problem-solving situations.

Mathematical concepts are arranged hierarchically from a simple concept to a complex concept, then the subjects of mathematics need to be given since primary school so that learners are able to master math concepts maturely. According to Kurniati, et.al (2015, p. 53) the statement means that the most important thing was learning mathematics at the elementary level because it occurs early during the development of cognitive abilities in students. Early cognitive development of learners in mathematics will affect further development of mathematical thinking and mastery of subjects affecting the others. Wimbari (Kurniati, et.al, 2015, p. 53) also asserted mathematics needs to be mastered elementary school students to help digest the sciences in higher education. Mathematics becomes very important to be given to primary school students so that they can master simple and complex mathematical concepts, because such complex mathematical concepts can only be mastered if learners have a good understanding of simple concepts so that when learners enter their higher education stages will not experience any significant difficulties.

Application and the benefits of mathematics to deal with the problems of everyday life is manifested in mathematical literacy. Mathematical literacy is an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens. (OECD, 2016a, p. 5).

Mathematical literacy is very important to be mastered by learners because it can help understand the role and usefulness of mathematics on aspects of everyday life and make the right decisions and reasoned. Literacy of learners in various countries can be seen from the results obtained from the assessment made by Programme of International Student Assessment (PISA). PISA is an international assessment to know the literacy of mathematics, reading, and science of 15-year-olds. Based on the results of PISA followed by 65 countries shows that Indonesian students' mathematics literacy is ranked 63<sup>th</sup> with a score of 375. This rating is worse than literacy reading that ranked 61<sup>th</sup> with a score of 396 and science literacy which ranked 62<sup>th</sup> with a score of 384 (OECD, 2016b, p. 5).

Mathematical literacy problems high school students did not rule out the impact of mathematical literacy problems and learning primary students. Mathematical literacy problems of primary school students have looked at some of the students were only able to understand a mathematical concept, but some students are still less capable of connecting between mathematical concepts and apply mathematics in reducing the problems found in everyday life. It is also marked on the presence of some students who are not able to give right answer the case stories, especially about non-routine related to mathematical concepts that are discussed in primary school

(Firdaus, 2017, p. 213). Charmila, et al (2016, p. 199) argues that the low achievement of Indonesian learners especially in PISA mathematics can be influenced by many things. One of the things that can be done to overcome them is to familiarize the students practicing questions about PISA models. The problems of the PISA model of mathematics are a matter of measuring the ability of mathematical literacy. Lin & Tai (2015, p. 390) state that PISA assessing students' mathematical literacy by examining how effectively learners can formulate, employ, and interpret mathematical problems that are appropriate to everyday life.

However, math literacy problems in primary schools are very rare, the questions given to learners are mostly routine questions that do not pay attention to the role of mathematics in the lives of learners. Based on the results of needs analysis conducted through the distribution of questionnaires in class 5<sup>th</sup> Elementary School, this happens because the teacher has not understood the mathematical literacy and its components. Mathematical literacy consists of 3 components, namely context, content, and competence. Context is divided into personal context, work context, community context, and scientific context. The content component consists of space and shape, changes and relationships, numbers, and probabilities. While the component of competence is divided into the competence of reproduction, connection competence, and reflection competence (OECD, 2009, p. 90, OECD, 2016a, p. 74). In addition to these three components, mathematical literacy also consists of level 1 to level 6, from the lowest achievement to the highest (OECD, 2016a, p. 77). According to Edo, et al (2013, p. 42) the cause of Indonesia's ranking is very low in PISA because Indonesian students are only able to answer PISA questions level 1 to level 3 and not many learners who can solve questions level 4 to level 6.

In addition to the above problems, other problems that cause bad math literacy is a matter given to learners is still questionable quality because the analysis of the problem is not done. This is in line with the findings in the preliminary study in Class 5<sup>th</sup> Primary Schools, it is known that no teacher is doing the problem analysis used in mathematical judgments. Assessment instrument is needed that can be used to measure mathematical literacy so that students' mathematical literacy skills can be measured so as to thrive. Assessment instrument that can be used to measure mathematical literacy can be a test instrument. According to CoPo (2015, p. 189) test is assessment that measures learners' learning. The test is said to be good if the test can reflect the learner's mastery. According to Novita & Putra (2016, p.34) the tests used in PISA to measure mathematical literacy are used to see how far learners can use the knowledge of learners learned in school effectively to deal with the various problems and problems they may face in life. Therefore, this study aims to develop a test instrument for measuring the mathematical literacy of V grade Elementary School students.

## 2. Methods

This research is a development research or Development Research Type Formative Evaluation (Tessmer, 1993). The product developed is a multiple choice-shaped test instrument and a description for measuring the math literacy of primary school students. This study consists of two preliminary and formative evaluation phases which include self-evaluation, expert reviews, one-to-one, small group, and field test.

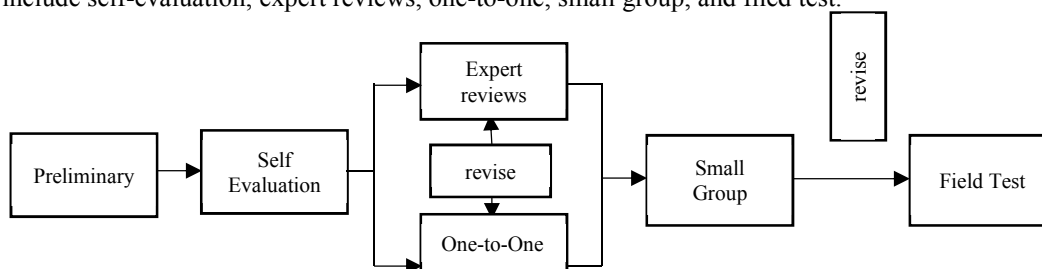


Figure 1. Formative Evaluation Design Flow

Population in this research is all class 5<sup>th</sup> learners at Elementary School. The sampling technique uses cluster technique. The sample in this research is 62 students of class 5<sup>th</sup> from Muhammadiyah Elementary School of Metro and Elementary School of 7<sup>th</sup> Metro.

### 1. Preliminary Step

#### a. Preparation

At this stage, an analysis of the curriculum is conducted to determine Basic Competence in class 5<sup>th</sup> which is in accordance with the research schedule.

#### b. Designing

At this stage, grating designing and mathematical literacy test instruments were performed.

### 2. Formative Evaluation Step

#### a. Self Evaluation

At this stage self-assessment of the design result of the mathematics literacy test instrument has been made. The result of design instrument test at this stage are called *Prototyp I*.

b. *Expert Reviews*

At this stage the design of created of the instrument test or Prototype I is viewed, assessed, and evaluated by the expert using a questionnaire to see the feasibility of the question. The expert consists of evaluation experts, material experts, and linguists. Suggestions from experts are used to revise Prototype I. The instrument feasibility analysis is obtained from the product validation results calculated using the formula:

$$\text{Final Score} = \frac{\text{obtained score}}{\text{maximum score}} \times 100$$

The final score is converted to the assessment criteria shown in table 1.

Table 1. Convert Expert Validation Value

Criteria	Value
Very Good	76 – 100
Good	51 – 75
Less	26 – 50
Very Less	≤ 25

c. *One-to-One*

In parallel (simultaneously), also performed stage one-to-one. At this stage Prototype I was tested against class 6<sup>th</sup> students because it has been given class 5<sup>th</sup> material in the previous lesson year.

d. *Small Group*

At this stage, class 6<sup>th</sup> students of Muhammadiyah elementary school were asked to complete Prototype II. Then the analysis of items about multiple choice form and description that includes the validity, reliability, difficulty level, and different power. The item analysis for multiple-choice forms is also seen in the distractor.

e. *Field Test*

This final prototype is tested to the research subjects of students of class 5<sup>th</sup> Isa of Muhammadiyah Elementary School and class 5<sup>th</sup> of Elementary School 7<sup>th</sup> Metro as many as 62 students. At this stage is also done the analysis of items that include the validity, reliability, difficulty, and differentiation. The item analysis for multiple-choice forms is also seen in the distractor.

### 3. Results and Discussion

This research is a development research that begins by conducting preliminary research on the mathematics literacy of learners in elementary school of Metro sub-district, Kota Metro, Lampung. Based on the results of research, it is found that the teacher has not understood the components of mathematical literacy so that the assessment of mathematical literacy is less attention. Assessment is a teacher activity intended to measure a certain competence or ability to the activities that have been implemented in the learning activities (Hosnan, 2014, p.387). Assessment information is needed to make decisions about learners' learning abilities, based on their abilities and achievements (Kankam Boadu, et al., 2015, p 62). Assessment to see the extent to which the literacy of mathematics learners can use the test instrument. However, during this test instrument made by the teacher has not been referring to the learner's mathematical literacy and less attention to the quality of the grain matter.

This study refers to research conducted by Octiningrum, et.al (2016) which states that the development of mathematical problems such as PISA can be used to assess students' mathematical literacy. So the problems of mathematical literacy developed in this study refers to the PISA theory. In addition, research conducted by Novita & Putra (2016) also produces math problems such as PISA which refers to mathematical literacy can assess and even encourage the development of student creativity in answering questions. The problem developed in Novita & Putra research is a matter of non-routine description so that the process of workmanship of students can be different to find the correct answer.

The development of test instrument in this research using Formative Evaluation design (Tessmer, 1993). Here is a process of researching the development of mathematical literacy test instruments.

1. Preliminary Step

a. Preparation

This stage is the determination of Core Competence and Basic Competence in class 5<sup>th</sup> in accordance with the research schedule.

- |                  |     |  |
|------------------|-----|--|
| Core Competence  | 3.  | Understand the factual and conceptual knowledge by observing and questioning based on curiosity about himself, God's creatures and activities, and objects he meets at home, at school, and on the playground. |
| Basic Competence | 3.7 | Describe the data relating to the learners themselves or the environment and how to collect it.  |
|                  | 3.8 | Explain the presentation of the data relating to the learners themselves and compare with the data from the surrounding  |

environment in the form of lists, tables, image diagrams (pictograms), bar charts, or line diagrams.

b. Designing

In the designing stage, the making of lattice and instrument of mathematics literacy test. At this stage there were 16 multiple choice questions and 8 description questions.

2. Formative Evaluation Step

a. Self Evaluation

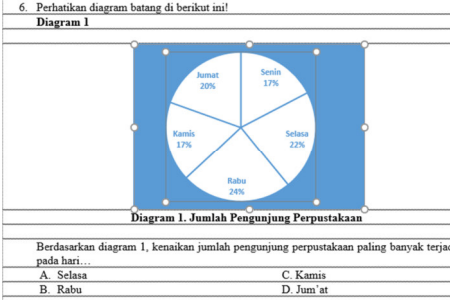
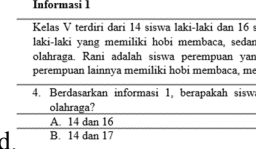
The test instrument produced at the preliminary stage is assessed by the self. Self-assessment of the design results of the mathematical literacy test instrument that has been made at this stage is called Prototype I.

b. Expert Reviews

At this stage the design of the test instrument created or Prototype I is viewed, assessed, and evaluated by the expert using a questionnaire to see the feasibility of the question. The expert consists of evaluation experts, material experts, and linguists. Suggestions from experts are used to revise Prototype I. Experts' comments and suggestions about the designs that have been made are written on validation questionnaires as materials for revising and declaring that the design of the test instrument has been feasible.

Table 2. Expert Advice on Prototype I and Decisions on Revised Action Measures

No	Expert Advice	Revision Decision																				
<b>Evaluation</b>																						
1.	Add 2 multiple choice questions and 2 description questions with lower levels of difficulty than the prototype questions.	Diperbaiki sesuai saran ahli evaluasi sehingga soal pilihan ganda 14 item menjadi 16 item dan soal uraian 6 item menjadi 8 item.																				
2.	Problem number 1 should be information about the data to be collected using a comma (,) only, not numeric.	Problem becomes: Mr. Adi is a chairman of the Neighborhood Association, he is given the task by the kelurahan to collect data of each family. The data needed is the number of family, age, religion, type of work and income. The ways that can be done to collect data on story 1 is: a) Interviews, questionnaires, literature studies and direct observation. b) Interviews, questionnaires, and literature studies. c) Interviews, questionnaires and direct observation. d) Interviews and questionnaires.																				
3.	Problem number 13 should be replaced because it is too complicated for class 5 <sup>th</sup> Elementary School.	Quiz be: 14. Perhatikan nilai olimpiade berikut ini! <table border="1" data-bbox="730 1249 1157 1384"> <caption>Tabel 5. Skor Cerdas Cermat</caption> <thead> <tr> <th>Skoring</th> <th>Peserta</th> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>Benar</td> <td></td> <td>5</td> <td>5</td> <td>4</td> </tr> <tr> <td>Salah</td> <td></td> <td>3</td> <td>2</td> <td>2</td> </tr> <tr> <td>Tidak menjawab</td> <td></td> <td>2</td> <td>3</td> <td>4</td> </tr> </tbody> </table> Ketetapan skoring menjawab benar adalah 4, salah adalah 0 dan tidak menjawab adalah 0. Maka siapakah peserta yang menjadi pemenangnya? A. Peserta A B. Peserta B C. Peserta C D. Peserta A dan Peserta B	Skoring	Peserta	A	B	C	Benar		5	5	4	Salah		3	2	2	Tidak menjawab		2	3	4
Skoring	Peserta	A	B	C																		
Benar		5	5	4																		
Salah		3	2	2																		
Tidak menjawab		2	3	4																		
4.	Problem number 12 multiple choice should be made into 2 to replace the number problem.	15. Jika ketetapan skoring olimpiade pada tabel 5 diubah menjadi menjawab benar adalah 4, menjawab salah -1 dan tidak menjawab adalah 0. Siapakah yang menjadi pemenangnya? A. Peserta A B. Peserta B C. Peserta C D. Peserta A dan Peserta B																				
<b>Material</b>																						
1.	Construction questions should refer to the indicator.	Corrected according to expert comments / suggestions.																				
2.	Information in the form of images or tables is presented more effectively.																					
3.	The assessment rubric for the description is made more specific.																					
<b>Language</b>																						
1.	The answer option should be capitalized.	Fixed as suggested																				
2.	Problems that use story stimuli, information, and data presentation in the form of tables, graphs, and diagrams should be numbered, eg story 1, information 1, diagram 1, and so on.	Fixed as suggested, for example: Story 1 Mr. Adi is a chairman of the Neighborhood Association, he is given the task by the kelurahan to collect data of each family. The data needed is the number of family, age, religion, type of work and income.																				

No	Expert Advice	Revision Decision
3.	Problems using story stimuli, information, and data presentation in the form of tables, graphs, and diagrams should not use the word 'above' but adapted to story numbers, information, and data presentation in the form of tables, graphs, and diagrams.	Fixed as suggested, for example: 
4.	The word 'between' on item number 3 is replaced 'by'.	Fixed as suggested. 

Expert test results obtained from expert assessment can be seen in Table 1. Based on the results shown in Table 1 it can be concluded that the developed instrument of mathematics literacy assessment is included in very good category.

Table 3. Expert Test Results

No	Aspect	Score	Note
1	Evaluation	83,33	Very Good
2	Material	100	Very Good
3	Language	100	Very Good

**Result of expert reviews**

c. One-to-one

Expert review and one-to-one are implemented in parallel. In the one-to-one phase, Prototype I tested the grade VI students because they were given class V material in the previous year. Eligible students are from Muhammadiyah elementary school with different ability with 1: 2: 1 proportion, ie high ability students: moderate: low. Selected students are 4 students with 1 proportion of high ability students, 2 medium-skilled students and 1 low-ability student. They are asked to interpret the instrument of questions made to see students' understanding of the given problem, as appropriate or not with the maker's intention. After the revised Prototype I will produce Prototype II.

Table 4. Learners Comments on Prototype I and Decisions on Revised Action Measures

No	Student Comments	Revision Decision
1.	Question 1 multiple choice of information presented is too long and complicated.	
2.	Question 2 multiple choice of data collected too much.	Question 1,2,5,10,14, and 15 are fixed.
3.	Question 5 multiple choice is very difficult to understand.	
4.	Question 10 of multiple choice of analysis is too difficult.	
5.	Question 14 multiple choice is too complicated because the reading is difficult to understand.	
6.	Question 15 multiple choice is too complicated because the reading is difficult to understand.	

d. Small Group

At this stage, students of class 6<sup>th</sup> Muhammadiyah Elementary School are required to complete prototype II. Then do the analysis of items that include the validity, reliability, difficulty, differentiation, and distractor. Based on the test instrument results obtained the following results.

1) Multiple Choice

Validity

Table 5. Multiple Choice Test Instrument Validity Test

Item Number	Quantity	Note	%
1,2,4,5,7,8,10, 11, 12,14,15	11	Valid	68,75%
3,6,9,13,16	5	Tidak Valid ( $r_{count} \leq r_{table}$ )	31,25%

The problem is said to be valid if r count is greater than r table. The R value of the tables in this group of questions is 0.4438. Problems are valid valid a number of 11 questions (68.75%) while the question is invalid invalid there are 5 questions (31.25%).

Reliability

Table 6. Test of Multiple Choice Instrument Test Validity

Item Number	Value r Count	Criteria
1-16	0,7876	Strong

Difficulty Level

Table 7. Difficulty Level of Multiple Choice Product

Category	Item Number	Quantity	%
0,00-0,30 (Difficult)	9,10,11,12,13,14, 15,16	8	50%
0,31-0,70 (Middle)	1,2,4,5,6,7,8	8	50%
≥0,71 (Easy)	-	-	-

Discrimination

Table 8. Discrimination of Multiple Choice Products

Discrimination Indexes	Item Number	Criteria
0,70-1,00	-	Very Good
0,40-0,69	2,3,5,7,8,10,11,12,15	Good
0,20-0,39	1,4,6,9,14	Good Enough
0,00-0,19	13,16	Poor
Negative	-	Not Good

Distractor

Table 9. The Effectiveness Distractor of Multiple Choice Product

Category	Item Number	Quantity	%
key rpbis a positive answer, Response > 5%, and rpbis distractor negative rpbis negative answer key, Response <5%, and positive distractor rpbis	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	16	100,00
	-	-	-

2) Essay

Validity

Table 10. Test of Instrument Validity Test

Item Number	Quantity	Note	%
1,2,3,4,5,6,7,8	8	Valid	100%
-	-	( $r_{hitung} \geq r_{tabel}$ ) Tidak Valid	0%
		( $r_{hitung} \leq r_{tabel}$ )	

According to test show that question is 8 item. The r value of the tables in this group of questions is 0.4438. All questions are valid or 8 (100%).

Reliability

Table 11. Validity Instrument Test of Essay

Item Number	Value r count	Criteria
1-8	0,8587	Very Strong



Difficulty Level

Table 12. Difficulty Level of Essay Product

Category	Item Number	Quantity	%
0,00-0,30 (Difficult)	6,7,8	3	37,5%
0,31-0,70 (Middle)	1,2,3,4,5	5	62,5%
≥0,71 (Easy)	-	-	-

Distractor

Table 13. Distractor of Essay Product

Distractor Index	Item Number	Note
0,70-1,00	-	Very Good
0,40-0,69	4,5,6	Good
0,20-0,39	1,2,3,7,8	Good Enough
0,00-0,19	-	Poor
Negative	-	Not Good

Based on the analysis of multiple choice test instruments and the above description, then the decision was generated that only 11 problems were tested in the field test stage, that is the number 1,2,4,5,7,8,10,11,12,14, dan 15. While the test instrument that is tested in the field test stage is entirely the number 1 to 8. Prototype generated at small group stage hereafter called Prototype III.

e. Field Test

This final prototype is tested to the research subjects of students of class 5<sup>th</sup> Isa Muhammadiyah Elementary School, class 5<sup>th</sup>B of 7<sup>th</sup> Metro Elementary School, and class 5<sup>th</sup>A at 9<sup>th</sup> Metro Elementary School as many as 62 students. At this stage also conducted a grain analysis of questions that include the validity, reliability, difficulty, discrimination. The item analysis for multiple-choice forms is also seen as follow.

1) Multiple Choice

Validity

Table 14. Test of Multiple Choice Validity

Item Number	Quantity	Note	%
1,2,3,4,5,6,7,8,9,10,11	11	Valid ( $r_{count} \geq r_{table}$ )	100%
-	-	Tidak Valid ( $r_{count} \leq r_{table}$ )	-

According to test show that question is 11 item. The r value of the tables in this group of questions is 0.254. Question declared valid amount of 11 questions (100%).

Reliability

Table 15. Multiple Choice Validity Test

Item Number	Value r Count	Criteria
1-11	0,808	Very Strong

Difficulty Level

Table 16. Difficulty Level of Multiple Choice

Category	Item Number	Quantity	%
0,00-0,30 (Difficult)	8,9,10,11	4	36,36
0,31-0,70 (Middle)	3,6,7	3	27,27
≥0,71 (Easy)	1,2,4,5	4	36,36

Discrimination

Tabel 17. Discrimination of Multiple Chice

Distractor Indexs	Item Number	Note
0,70-1,00	3,5,7,8,9,10	Very Good
0,40-0,69	6,11	Good
0,20-0,39	1,2	Good Enough
0,00-0,19	4	Poor
Negative	-	Not Good

Distractor

Tabel 18. Effectiveness Distractor of Multiple Choice

Catagori	Item Number	Quantity	%
key rpbis a positive answer, Response > 5%, and rbis distractor negative	1,2,3,4,5,6,7,8,9,10,11	11	100,00
rpbis negative answer key, Response < 5%, and positive distractor rpbis	-	0	0

2) Essay

Validity

Tabel 19. Validity Instrument Test of Essay

Item Number	Quantity	Note	%
1,2,3,4,5,6,7,8	8	Valid	100%
-	-	( $r_{count} \geq r_{table}$ ) Tidak Valid	0%
		( $r_{count} \leq r_{table}$ )	

The question is valid if r count is greater than r table. The R value of the tables in this group of questions is 0.254. All questions are valid or 8 (100%).

Reliability

Tabel 20. Validity Instrument Test of Essay

Item Number	Value r Count	Criteria
1-8	0,9659	Very Strong

Difficulty Level

Tabel 21. Difficuly Level of Essay Product

Categori	Item Number	Quantity	%
0,00-0,30 (Difficult)	8	1	12,5%
0,31-0,70 (Middle)	2,3,4,5,6,7	6	75%
$\geq 0,71$ (Easy)	1	1	12,5%

Discrimination

Tabel 22. Discrimination of Essay Product

Discrimination Indexs	Item Number	Note
0,70-1,00	-	Very Good
0,40-0,69	4,5,6	Good
0,20-0,39	1,2,3,7,8	Good Enough
0,00-0,19	-	Poor
Negative	-	Not Good

Based on the analysis of multiple choice test instruments and the above description, then the question of quality double choice is entered into the bank about as many as 10 questions, namely item number 1,2,3,5,6,7,8,9,10,11 because the question valid, reliable, difficulty level, different power and distractor meet the criteria while item 4 number of the power difference is bad even though the valid, reliable, and difficulty level



meets the criteria. While the test instrument description that can be entered into the bank about as many as 8 items because the problem is valid, reliable, different power and difficulty level meet the criteria.

#### 4. Conclusion

Based on the results of research and discussion, it is concluded that the final product in this study produces an assessment instrument to measure the mathematics literacy of elementary school students class 5<sup>th</sup>. Problems developed in accordance with the rules of questioning. The feasibility of the instrument is evidenced by the results of the expert's judgment indicating that the instrument is eligible to be used based on a review of the evaluation, material, and language aspects. The instrument has also met the valid and reliable criteria. The multiple-choice question has a moderate degree of difficulty, good distinguishing power, all of the cleverly functioning. Problem description also has a moderate level of goodness and good distinguishing power.

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