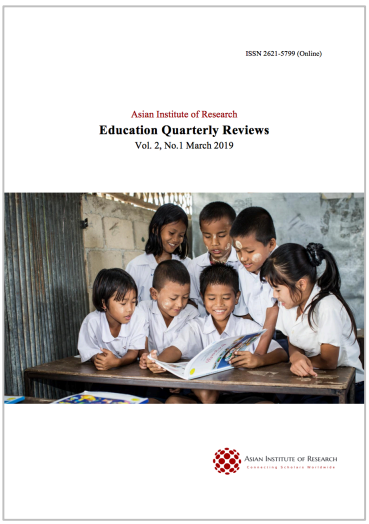

Education Quarterly Reviews

Hidayat, Muhammad, Syahputra, Edi, and Napitupulu, E. Elvis. (2019), The Development of Learning Media Based on Problem by Using *Rubu' Al-Mujayyab* Media. In: *Education Quarterly Reviews*, Vol.2, No.1, 198-209.

ISSN 2621-5799

DOI: 10.31014/aior.1993.02.01.53

The online version of this article can be found at:
https://www.asianinstituteofresearch.org/

Published by:
The Asian Institute of Research

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The Asian Institute of Research
Education Quarterly Reviews
Vol.2, No.1, 2019: 198-209
ISSN 2621-5799

DOI: 10.31014/aior.1993.02.01.53

The Development of Learning Media Based on Problem by Using *Rubu' Al-Mujayyab* Media

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Abstract
This research is included into development research type. This research uses a 4-D model (define, design, develop, and disseminate) Thiagarajan, Semmel, and Semmel. This research is organized by learning media and instruments, namely: the student's handbook, the teacher's handbook, lesson plan, the student's exercise sheet, the student's mathematical problem-solving ability test. Tests conducted on grade X as many as 26 people in Madrasah Aliyah Muhammadiyah (MAM) 1 Medan. The results of this research indicate that: (1) learning media fulfills the valid criteria according to the experts or validator. The learning media fulfills the practical criterion, i.e. validator stated that learning media could be used with small revisions and the implementation of problem-based learning media by using Rubu ' Al-Mujayyab lies on criteria IO = 4.35 high. The learning media fulfills the criteria of effective learning until 88%. The teacher's ability in managing learning process obtained an average of 4.08 categorized well, the achievement of the ideal time percentage of the activity of the students are in the attainments the ideal time of the activity of students with a tolerance of 5%, and the response of the students towards the learning obtained an average of 95.02%.

Keywords: Learning Media, Problem-Based-Learning, *Rubu' Al-Mujayyab*

1. INTRODUCTION

Education is the right facilitator in shaping societies and nations that aspired to, i.e., that cultured society and can solve the problems they faced every day. One of the science discipline has an important role in the era of globalization, namely mathematics. The role is seen in various sectors of human life such as computerization, transport, communications, economic/trade and development of science and technology (Masrinawati, 2003) and the students are expected to use mathematics and mathematical thought patterns in everyday life, and learning various types of science that emphasize logical rules and also the ability to apply mathematics (Saragih & Napitupulu 2015), straightened by Phonapichat, etc. the main teaching of mathematics is to enable students to solve problems in everyday life. Therefore, the importance of mathematics to be taught to students because mathematics is always used in everyday life (Banjarnahor, et al., 2017; Pinter, 2012).

One of the purposes of learning mathematics at school is the students are able to solve the mathematical problem, undoubtedly it is the heart mathematics activity and learning mathematics, as Napitupulu, (2008) wrote that problem solving is undoubtedly the heart of mathematical activities. Someone who does not have certain

rules/laws that can immediately be used to find answers for a mathematical question is called a mathematical problem (Hudojo, 2005).

But the specific fact is the student's mathematical problem-solving ability at schools is still low based on the mathematical problem-solving ability indicator according to the model of Charles, Lester, & O'Daffer [4]. This is demonstrated by observations made in MAN 1 Medan. From the results of mathematical problem-solving ability test provided the researcher to 25 students, the average score obtained by students was 40.63 then it proves that the student's mathematical problem-solving ability is still low, according to the categories of classification of the student's mathematical problem-solving abilities. From all cases that have been presented above shows that the ability of problem-solving to problems given is still low so that the student's learning achievements leads to the decrease. This possibility is caused by several things, including the learning that takes place now is less associated with the experience of students learning patterns, and less emphasis on mathematical problem-solving capabilities, in the learning process, the teacher is expected to choose a learning model that suits the material being taught. Learning Model is a design that depicts the process details and the creation of environmental situations that allow students to interact so that the developments or changing occurs to the student. (Amri, 2013).

Nowadays, teachers are also required to be able to apply learning models that are more centered on the students. Teacher based learning is no longer dominant, but more emphasis is on two-way interactions between teacher and student. The learning process will be better if there are more tangible interactions between students and teachers. (Sapta 2018) the same pinion is also stated by Amri (2013) that teachers should also be able to create a good learning media, that demands competence that should be owned by the teacher (pedagogy competence, personality competence, social competence and profession competencies), development of learning is one of the obligations which demands the teachers to develop competencies that are owned by them, in turn, can improve their existence as a professional teacher, the development of learning media is one of the obligations that teachers must carry out to develop their competencies, which in turn can increase their existence as professional teachers.

Learning media developing is not only useful for improving the students' abilities but also useful for teachers to improve the quality of their teaching and professional development (Azwar, et, al., 2017). One important factor that influences the teacher's success is to create a learning media. The learning media consists of the lesson plan (RPP), the Student's Activity Sheet (LAS), the student's handbook, the teacher's book. The quality of the media can be seen from the criteria articulated according to Nieveen [7]. A material can be said having a high quality if it fulfills the quality aspects, namely: (1) validity, (2) practically, and (3) effectiveness.

Learning media which will be used is Rubu ' Al-Mujayyab (Sine Quadrant). Rubu ' Al-Mujayyab astronomical instruments are the classic shape of a quarter circle with a simple design, and this tool has a specific function that is as a determiner of altitude and time (Butar-Butar, 2016). *Rubu' Al-Mujayyab* used by the muslim astronomer and later replaced by a lot of diversity of quadran *(*King, 2005) and untl now, *Rubu Al-Mujayyab* is still used by some (Muslim) people in Indonesia to calculate and determine the direction of the Qibla (Qibla) and the longtitude of the ecliptic and declination of the sun (Setyanto, 2004).

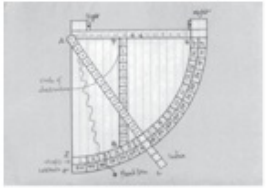

Figure 1. *Rubu Mujayyab* (Lindegaard, 2014)

Darren (1994) stated that the central part of the quadran gives an image which is available to see the distance of the Sun from zenit on meridian lines. *Rubu 'Al-Mujayyab* that developed in Indonesia is *Rubu' Al-Mujayyab* which is relatively small, which is ± 23 cm in size and made of various materials such as wood, plastic, and

brass. (Sakirman, 2018). There is also *Rubu 'Al-Mujayyab* which made of tusk and softer than the one made by brass and has two latitudes (Turner, 1997).

Rubu' Al-Mujayyab is a classic tool that will assist students in understanding the relationship between the science that they have learned with the natural surroundings and are expected to enhance the mathematical problem-solving ability, especially at the subject of trigonometry.

This model-based learning model is an approach to teach students about authentic (real) problems so the students can build their own knowledge, develop high skills and investigations, to be independent students, and increase self-confidence (Trianto, 2011). Learning with the PBL model is one of the learning which centered on students and the teachers as the facilitators.

Arends (2004) states that problem-based learning (PBL) is designed to train students 'abilities in solving mathematical problems, this is supported by Minarni (2012) states that learning based on problems significantly provides a better influence on achieving students' mathematical problem-solving abilities than conventional learning. In the PBL model having the learning steps proposed by Trianto (2011) is shown in Table 1. below:

Table 1. Main Steps of Problem Based Learning Model

Phase	Step	Teacher's Activity
1	Orienting students to problems	· Teacher explains the purpose of learning · Describes the required logistics · Motivate students involved in selected troubleshooting activities
2	Organize students to learn	· Teachers help students define and organize learning tasks related to the problem
3	Guiding individual and group	· Teachers encourage students to gather appropriate information, to carry out experiments, to gain clarity and problem solving
4	Develop and present the work	· Teachers assist students in planning and preparing suitable works such as reports, videos, and models and helping them to share the task with their friends
5	Analyze and evaluate the problem-solving process	· Teachers help students to reflect on their investigations and the processes they

2. METHOD

This research is development research. Development research is research that is used to develop or produce products or improve existing products (sugiyono, 2009; sukmadinata, 2012). This research is categorized as development research by using thiagarajan, semmel semmel development model namely 4-d model (define, design, develop, disseminate).

The subjects in this study were class X Muhammadiyah 1 Medan Aliyah Madrasah totaling 26 students in the academic year 2017/2018, while the objects in this study were media-based problem-based learning tools *Rubu 'Al-Mujayyab* on trigonometric material in the form of lesson plans (RPP), teacher's book (BG), student's book (BS), student worksheet (LAS), the results of the test of mathematical problem-solving ability.

Table 2. Intruments and Data Analyze Technique

The Aspect Scored	Instrument	The Data Observed	Respondence
Validation of problem-based learning media	Validation sheet	Lesson plan (RPP), teacher's book, student's book, student's worksheet (LAS), mathematical problem-solving ability	Expert/Specialist

Problem-based learning media practice	Observation sheet	Responses from the experts or validators	Expert/Specialist
	Observation sheet	Learning activity	Observer
The effectivity of learning	Test	Problem-solving ability test	Student
	Question	The student's response	Student
	Observation sheet	The teacher's ability to control the learning activity	Teacher
	Observation sheet	The achievement percentage of the student's activity ideal time	Student

The development of learning media is said to be of quality if it fulfills three aspects, which are valid, practical and effective. Learning media has a good degree of validity if the minimum level of validity achieved is in the valid category. If the level of validity is below the valid category, then revisions are made based on the input of the validators. Revisions are carried out until valid learning devices are obtained.

The results obtained are then written in the appropriate column in the table. Furthermore, this *Va* value or total mean value is referred to as the interval for determining the validity level of learning media based approach, can be seen in Table 3. as follows:

Table 3. The Criteron of Validity Level

No	*Va* or total score of average	Validity Criteria
1	$1 \leq Va < 2$	Not Valid
2	$2 \leq Va < 3$	Quite Valid
3	$3 \leq Va < 4$	Valid Enough
4	$4 \leq Va < 5$	Valid
5	$Va = 5$	Very Valid

The learning media are said to be practical if the validator states that the learning media developed can be used in the field with little revision or without revision and practicality. Learning media is measured based on the observer's assessment results to state whether the media can be implemented or not in the classroom using the provided learning media (Intended-Opera or IO). The instrument used is the observation sheet of the implementation of learning media that has been developed. Activities carried out to analyze the implementation data obtained from the results of observations are as follows:
To determine the score of *Va* or the average score for all aspects:

$$IO = \frac{\sum_{i=1}^{n} A_i}{n}$$ (Susanto, 2012)

Description:
Io is the total score of average for all aspects
is the average score for the –*i* aspect
n is the amount of aspect

Furthermore, the average aspect value (IO) is referred to as the interval for determining the level of implementation of the media as follows:

Table 4. The Criterion of Learning Activity

Interval of Score	Criteria
$1 \leq IO < 2$	Very low
$2 \leq IO < 3$	Low
$3 \leq IO < 4$	Medium

$4 \leq IO < 5$	High
$IO = 5$	Very high

The criterion states that the media has a good degree of IO is a minimum level of OI achieved is high. If there is consistency between the results of the expert and practitioner's assessment with the results of observing the implementation of the media in the field by the observer (intended), namely that the results of the assessment are high, the media meets the criteria of practicality.

The learning media is categorized as effective if learning outcomes using learning media show: 1) Student's mastery in learning is classically fulfilled, 2) students' positive responses of learning. Each student is said to have completed his study (individual provisions) if the proportion of answers is 75% correct and a class is said to be complete learning (classical provisions) if in that class there are 85% of students completing their studies (Trianto, 2011).

According to Trianto (2011) based on the provisions of the curriculum the determination of learning conditions is determined by each school known as the minimum completeness criteria (KKM), based on three considerations, namely: the ability of each student is different, facilities (facilities) each school is different, and the carrying capacity of each student is different. So in this study, according to the KKM at the school where the researcher conducted the study, the individual completeness was 70, and the classical completeness was 85%. Based on the explanation above, to find out the percentage of students' abilities obtained by each cycle, the formula used is:

$$Final\ Score = \frac{student\ score}{total\ score} \text{ x } 100$$

To see the mastery in a classical way, we can use the formula:

$$Classical\ complete = \frac{total\ students\ who\ complete\ learning}{total\ research\ subject} \times 100\%$$

The action is considered successful if at least 85% of students reach the KKM. If it is less than 85%, the action is considered unsuccessful.

The ability of the teacher to manage the learning process is the ability to develop a friendly and positive learning atmosphere, including the ability to open learning, organize learning, close learning, managing time and manage the learning climate. Based on observations made by the observer in the implementation of learning, the ability of the teacher to manage the learning process is determined by the average score given by the observer of the rating scale as follows:

$$KG = \frac{\bar{A} + \bar{B} + \bar{C} + \bar{D} + \bar{E}}{5}$$

Description:
KG = the teacher's competence
$\bar{A}$ = the average score of opening the class ability
$\bar{B}$ = the average score of organizing the learning
$\bar{c}$ = the average score of closing the learning
$\bar{D}$= the average score of managing the time
$\bar{E}$= the average score of managing the learning atmosphere

Teachers are said to be able to manage to learn if the average score is in good enough category. The student's response data obtained through questionnaires were analyzed based on percentages. The percentage of each response are calculated by the number of student responses on each aspect that appears divided by the number of all students multiplied by 100%.

$$RS = \frac{f}{n}\ x\ 100\% \quad \text{(Herman, 2012)}$$

Description:
RS = the student's percentage with the certain criteria
f = the amount of agreed students
n = the amount of students

The students' responses are said to be positive if 80% or more of the students respond in positive categories (happy, new, clear, and interested) for each aspect that is responded to. The data from observations of student activities during learning activities are analyzed based on percentages. The percentage of student's activity is the frequency of each aspect of observation divided by the number of frequency of all aspects of observation multiplied by 100% or,

$$Persentage\ of\ student\ activity = \frac{Frequency\ aspect\ of\ observation}{Total\ frequency\ of\ all\ aspects\ of\ observation}\ x\ 100\ \%$$

The determination of the effectiveness of student's activity criteria based on the achievement of the ideal time set in the preparation of a realistic mathematical approach plan, as shown in Table 5. As follows:

Tabel 5. The Student's Activity Effectiveness

Category of the student's activity	Effectiveness percentage (P)	
	Ideal Time	PWI Tolerance Interval 5 %
(1)	(2)	(3)
1. Listening/paying attention to the teacher/friend's explanation	25 % dari WT	20 % ≤ PWI ≤ 30 %
2. Reading/comprehending the contextual problem on the book/LKS	15 % dari WT	10 % ≤ PWI ≤ 20 %
3. Solving /finding the answer from the problems	25 % dari WT	20 % ≤ PWI ≤ 30 %
4. Discussing/asking to the teacher/friend	25 % dari WT	20 % ≤ PWI ≤ 30 %
5. Making a conclusion from a procedure/concept	10 % dari WT	5 % ≤ PWI ≤ 15 %
6. The student's behavior which is not related to the learning activity	0 %	0 % ≤ PWI ≤ 5 %

Source: *Modified* from Sinaga (2007)

Description:
PWI is the ideal percentage of time
WT is the time available at each meeting

The criteria for achieving the effectiveness of student activities in learning is if the six categories of the student's activity above met with a tolerance of 5%. Note that the criteria for tolerance limits 3 and 5 must be met. The result of the analysis is used to revise the media.

3. RESULT

The results of the media trial activities produce data on validity, practicality, and effectiveness. Validity data was obtained from two mathematics education lecturers who assessed the developing learning media. The validation result of learning media is shown in Table 6 below:

Table 6. Summary of Learning Media Validation Result by Experts

No	Object Scored	The Average Score of Total Validity	Validity Level
1	Buku Siswa student's book	4,26	Valid
2	Buku Guru Teacher's book	4,17	
3	Lesson Plan	4,06	
4	Student's worksheet	4,21	
5	Problem-solving ability test	-	
6	Independencyof learning questionnaire	-	

Trial I

In this study, there were 2 indicators of practicality applied, namely the response of a team of experts or validators stating that learning media could be used with minor revisions and the implementation of problem-based learning tools assisted by *Rubu 'Al-Mujayyab* in the IO criteria = 4.35 high.

Besides the practicality aspect, effectiveness is also needed as a condition of good learning media. In this study, there are 4 indicators of effectiveness were determined, namely the achievement of student learning completeness. The data of the field trial results for mathematical problem-solving abilities can be seen in Table 7 below:

Table 7. The Student's Learning Mastery Achievement

Category	*Pre-Test*	Precentage of classical mastery	*Post-Test*	Precentage of classical mastery
	Amount of student		Amount of student	
Mastered	6	23 %	19	69 %
Not mastered	20	77 %	7	31 %
Sum	26	100 %	26	100 %
Average	58,3		73,3	

From Tabel 7. Above, it can be seen that the class average of the student's mathematical problem-solving ability in the pre-test trial i was 58.3 while the class average of the student's mathematical problem-solving ability in the post-test trial i was 73.3.

The ability of teachers to manage learning was obtaining an average of 3.9 or in the category of "good" the achievement percentage of ideal time of the student's activity was in the ideal time achievement of the student's activity with a tolerance of 5% and student responses to learning obtained 78.9%

Trial II

The implementation of problem-based learning media assisted by *Rubu 'Al-Mujayyab* at the first meeting had a level of learning implementation in the IO criteria = 4.35, high ($4 \leq IP < 5$). In general, the Pilot Test 2 had a level of IO learning implementation = 4.35, high. Thus, the problem-based learning tool assisted by *Rubu 'Al-Mujayyab* has fulfilled practical criteria empirically. The data from trial II for mathematical problem-solving ability can be seen in Table 8. below:

Table 8. The result of the mathematical problem-solving ability

Category	*Pre-Test*	Precentage of classical mastery	*Post-Test*	Precentage of classical mastery
	Amount of		Amount of	

	student		student	
Mastered	2	7 %	23	88 %
Not mastered	24	93 %	3	12 %
Sum	26	100 %	26	100 %
Average	54,9		80,1	

It can be seen that the class average of the student's mathematical problem-solving ability in the pre-test trial II amounted to 54.9 while the class average of the student's mathematical problem-solving ability in the post-test trial II was 80.1. The total average ability of the teacher to manage learning using a developing learning media in the second trial is 4.08 and is in the "GOOD" category. All aspects of the teacher's activity in managing learning also reach the category of "GOOD."

Percentage of achieving an ideal time of activities carried out by the students during the learning process took place using a problem-based learning media during the first and the second trial is on the threshold of effectiveness that has been set for each aspect. So that it can be concluded that in terms of the percentage of achieving the ideal time of student activity, it can be said that this learning device based on realistic mathematical approaches is effective for use in learning.

The student's response to all aspects, especially to learning medi, is the student's opinion on the learning component which consists of the student's book, student's activity sheet, and tests of mathematical problem-solving abilities which are 95.02%.

Based on the criteria of an effective device, namely the achievement of the target of student learning completeness, the ability of the teacher to manage learning and learning time that is not much different from the usual learning time and student responses obtained, the learning device used in the trial II has been effective.

4. DISCUSSION

From the description above, there is a quality of learning media, namely a media that has been developed and fulfills the valid, practical and effective criteria. The learning media that fulfills good valid aspects according to Rahman and Amri (2013) that the validity aspect refers to the extent of the design of the devices developed based on content validity and construct validity. Akbar (2013) adds that high validity is obtained through validation tests on learning devices developed. From the opinion of experts, it is also supported by the research of development carried out by Hasibuan, et. Al. (2018) Where, Based on the expert team of validation and revisions made, it was found that the development of learning media carried out on the teacher's books, student's books, RPP, LKS and tests that the results of device validation are in the category of valid, practical and effective and can be applied. In line with Ja'far, et al. (2014) where, the learning tools produced in this study include the Lesson Plan (RPP), student books, and Student Worksheets (LKS) that are character-based consistent and meticulous using the RME approach. Based on the results of validation and field trials the learning media developed have met valid criteria.

The learning media that has been developed meets the practical aspects of good or easy categories to be implemented. Practicality is that the learning media that is arranged considers the convenience aspect. Ease in the sense that compiled learning media can be easily understood and also easy to implement or use (Nieveen, 1999). According to Arikunto (2012), it means that practicality in educational evaluation is the facilities available in evaluation instruments both in preparing, using, interpreting/obtaining results and in saving. This is supported by the results of Riskasusanti, et. al., (2017) in his research showed a significant increase in student's problem-solving ability in four schools in three districts/cities in North Sumatra and this study compiled teaching materials in the form of textbooks and teacher manuals that included structured steps to solve problems mathematics based on problem-solving that can build high-level thinking.

The results of this study are also in accordance with the result of Simamora's et al. (2018) showing that the integration of local culture in mathematics learning is an important thing to consider in an effort to maximize the

student's mathematical learning achievements and reinforced Hidayat (2017) concluded that by using media *Rubu' Al-Mujayyab* the student's mathematical learning ability increases, this is indicated by an increase in classical learning completeness reaching 54% in the first cycle increased to 70% In the second cycle then in the third cycle increased to 87%. According to the research of Ammamiarihta, et. Al., (2017) that "Learning media has met the practical criteria in terms of the validator. The response to learning media is good and can be used with little revision, and the implementation of problem-based learning media is good". The meaning is that learning media meets good practical criteria and can be used with little revision. In addition, research conducted by Purwanti (2017) states that the results of the trials have met the practical criteria with the category "very easy to implement." The data is supported by observational data on the implementation of mathematics learning with the PBM model, with an average percentage of implementation reaching 91.67%.

The learning media that has been developed meets the effective aspects in terms of the completeness of learning classically and positive student's responses. Based on the results of the analysis of trials I and II, it was found that the student's mathematical problem-solving ability has met the classical completeness criteria. This is because the material and problems on the student's book and activity sheet are developed according to the conditions of the student's learning environment and refer to problem-based learning. With the application of problem-based learning tools, students will be actively involved in the problem-solving process. Students analyze and evaluate their own thought processes and draw conclusions from knowledge found with instructions and guidancse from the teacher or friend in the form of questions that lead. This is reinforced by Vygotsky (Rusman, 2012) namely, learning based on problems is an effort to associate new information with cognitive structures that have been owned through learning activities in social interaction. Vyotsky (Arends, 2008) adds social interaction with other people both teachers and peers refer to constructing new ideas and increasing students' intellectual development. This is supported by the results of Minarni and Napitupulu (2017) in his research that developed teaching material based on Joyful Problem Based Learning (JPBL) concluded that the learning material developed was very effective in improving student MRA and strengthened Minarni's research results (2017) Student performance in solving problems, understanding mathematics is better in the JPBL class than conventional one.

According to Vigotsky's theory (in Trianto, 2011), namely: (1) the closest development zone (zone) (zone of poximal development); i.e., learning occurs when children work or learn to handle tasks that have not been studied but the tasks are still in their abilities, or those tasks are in the zone of poximal development; and (2) scaffolding, namely giving a large amount of assistance to a child during the early stages of learning, then the child takes over the responsibility that gets bigger as soon as he can do it himself. The positive response given by students is caused because the teacher has given stimulus in the form of feedback and reinforcement that is in accordance with the characteristics of students after learning the state of the class. In line with the opinion of Subandi (1982) that the response in terms of feedback (feedback) has a response or a large influence in determining whether or not a communication. In other words, the teacher is a component that determines the implementation of a learning strategy.

This statement is in line with Sanjaya (2010), namely the learning process is a complex process, which must take into account the various possibilities that will occur, those possibilities which then require careful planning from each teacher. A teacher must prepare a mature and accurate learning process because with learning planning the teacher will predict how much success will be achieved. This is reinforced by Surya and Syahputra (2017) concluded that a concrete learning model could be implemented to improve students' high-level thinking skills in solving mathematical problems.

The learning process experienced by students in this study has gone through the process of assimilation and accommodation also in the Zone of proximal development. This can be seen from the successful development of a mathematical learning tool on trigonometry using the development model of Thiagarajan, et al., better known as the 4-D model.

Learning tools developed in this study include lesson plan (RPP), Teacher's Books (BG), Student's Books (BS), Student Activity Sheets (LAS), tests of student's mathematical problem-solving ability. All the learning media developed use problem-based learning assisted by *Rubu 'Al-Mujayyab*.

Fulfillment of the validity aspect is in line with the opinion of Akker (1999) which states that validity refers to the extent of the design of the device based on the latest state of technology, art or science ('content validity') and various components of the media consistently related to each other (' construct validity).

5. CONCLUSION

From the discussion above, it can be concluded that mathematical problem-solving ability increase after implementing the learning media based on realistic mathematical approaches that have been developed. This study shows that the quality of learning media must have valid, practical and effective criteria.

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