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Mathematics Learning Media Development Using Realistic Mathematics Education

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ABSTRACT

This research aims to develop learning mathematics media using proven validity-PMR approach, practicality and effectiveness in improving HOTS of Junior High School students class VIII. This type of research was the development of ADDIE model consisting of analysis, design, development, implementation and evaluation. The tests were carried out in four phases, expert test, limited test, field test, and effectiveness test. The subjects in this study were teachers and students. The instruments used were validation sheet, student's questionnaire, observation sheet and instrument test. The results show the learning media developed has fulfilled validity, practicality and effectiveness aspect. (1) The validity result shows the developed learning media in the category very valid with the average value on syllabus 3.81. While the learning plane (RPP) is 3.62, and student worksheet (LKPD) is 3.51, and test instrument is 3.45. (2) Limited test results shows the developed mathematical learning media in very practical category with score of 3.41. (3) Field test result shows the learning media developed is very practical, on teacher learning implementation observation sheet 3.62, on the student's questionnaire 3.44. Finally, the developed learning media can be ready to use in the school.

1. Introduction

In digital era, students can access information easily, quickly, and abundantly from many sources. Students are required to have the ability to acquire, choose, manage, and follow up information to be exploited in dynamic, challenging, and full of competition. One of the skills needed at this time is higher order thinking skills (Abdullah et al., 2019). Higher order thinking skills are required for students to face complex situations in daily life (Nugroho, 2018). Higher order thinking skills will make students able to construct proper and effective arguments

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in making decisions or find rational solutions (Rosnawati, 2009). Higher order thinking skills owned by students can help solve problems in everyday life.

Higher order thinking skills are ability to connect, manipulate, and transform knowledge and experience that already have to think critically and creatively to make decision and solve problems in new situations (Rofiah, 2013). Higher order thinking skills are process of thinking involving critical and creative information processing in particular situation or resolving a particular problem (Musfiqi et al., 2014). Furthermore Sani (2019) expressed higher order thinking skills including mathematical critical thinking abilities, mathematical creative thinking skills and mathematical problem solving skills.

Improvement in higher order thinking skills have been one of the priorities in 2013 curriculum. The 2013 curriculum demands students to think, process, and present creative, critical, independent, collaborative, and communicative skills through series of learning by observing, trying, finding, serving, concluding, creating.

Developing higher order thinking skills in mathematical learning is to equip skilled students with reasons and decision making skill. Higher order thinking skills are very important aspects to be developed in mathematics learning because in resolving real problems, students need critical thinking and creative ability (Susanto et al., 2016). Solving not routine problems in math learning, demanding students not only remember formulas, determine a value using formulas but students should also be able to find formulas and solve problem using these formulas so, it takes higher order thinking skills.

Through mathematical learning activities, teachers can develop higher order thinking skills. Teachers can design learning with an approach containing steps to improve higher order thinking skills, such as in understanding problem activity, choosing arguments, communicating problems solving problems in different ways, concluding, and in making decisions. Higher order thinking skills application in learning will make students accustomed to analyzing, ethical and creative in resolving problems found in life.

Students's higher order thinking skills in mathematics learning are still classified in low category (Susanto et al., 2016). Program for International Student Assesment (PISA) 2018 showed average Indonesia score 379 below average international score 489 ranked 74 from 79 countries in the world. Mathematics learning process in classroom, teachers generally tend to concentrate on procedural exercises and accommodate lower order level thinking development of and lacking in developing higher oder thinking skills. Sani (2019) stated in general learning at middle school usually implement basic level thinking skills test.

Preliminary research suggested higher order thinking skills need to be improved at SMPIT Al-Fityah Pekanbaru. The survey was conducted by providing two questions measuring higher order thinking skill about number patterns to 24 VIII

grade students acquired students' higher order thinking skills need to be improved. The result of analysis shows only two students who have higher order thinking skills. The result of interview with students shows students have difficulty completing number pattern material because they are not accustomed to working on problems requiring higher order thinking skills. The result of survey shows there is still a need for increasing mathematics learning efforts focused on improving higher order thinking skills.

One effort to develop higher order thinking skills in learning is through learning plan. Learning plan is designed in form of learning media. One of learning media which can develop higher order thinking skills is student's activity sheet (Yennita et al., 2018). Planning a well-designed learning process to the needs of students in student's activity sheet can help learning process become interactive, inspirational, enjoyable, efficient, motivating students to actively participate, and providing ample space to increase students' higher order thinking skills.

Most teachers have not yet developed learning media match with student's need (Sari, 2016). Mathematics learning is still very rare in learning media especially designed using a learning approach to develop students' higher order thinking skills (Susanto et al., 2016). Learning media created by teachers are formality and do not depict activities involving students' activities.

Based on interviews and observations results at Junior High Schools Pekanbaru City regarding RPP and LKPD used, teachers use RPP and LKPD which emphasize only lower order thinking skills. Learning media used by teachers have not helped students developing their students' higher order thinking skills. Learning media is indispensable for enhancing higher order thinking skills through activities.

Learning media are adjusted to learning approach used. A learning approach which can cultivate higher order thinking skills is a learning approach which is designed according to constructivism view. A learning approach which uses contextual issues as a starting point to show mathematics is actually related to daily life is a Realistic Mathematics Education (PMR) approach. PMR is a mathematical learning approach using contextual problems as first step in the learning process (Isrok'atun, 2018).

PMR approach requires students to construct knowledge with their own abilities through activities carried out in the learning activities (Ramadhani, 2017). PMR approach emphasizes mathematical process skills, discussing and collaborating with classmates so they can find themselves and finally use mathematics to solve problems both individually and collectively (Wijaya, 2012).

Learning activities using PMR approach can encourage in developing higher order thinking skills (Mufidah, 2017). Through PMR approach students can have the ability and mathematics mastery. PMR can help students rediscover the concepts of mathematics that have been studied or materials that have not been studied, and even find new things.

There are several principles as theoretical basis of PMR, these are: a) Guided Reinvention Principle and Progressive Mathematization Principle; Guided Reinvention Principle is emphasis on guided "re-discovery". b) Progressive Mathematization Principle is an effort leading to mathematical thinking which is horizontal mathematics to vertical mathematics. c) Didactic Phenomenology; This principle emphasizes educational phenomenon and emphasizes importance of contextual problems to introduce math topics to students. d) Build your own model; This third principle indicates a "bridge" function in form of a model (Susana, 2008).

The PMR main principle is described as the characteristic of PMR. The characteristic of PMR are: 1) initiates mathematical learning with a real problem, 2) use model as a bridge between real and abstract that can help students learning mathematics at the level of abstraction, 3) Use students' own contributions or strategies, (doing mathematic), 4) Maximize interaction between students, students-teachers, and students-learning resources, 5) associate mathematical materials with other mathematical topics (Treffers, 2012).

The main PMR characteristics can be described as steps in learning. The steps of applying PMR approach are understanding contextual issues, explaining contextual issues, resolving contextual issues, discussing problem solving and comparing, and concluding learning materials (Rahmawati, 2013). Widyastuti (2014) also explained that PMR learning implementation steps are understanding contextual issues, explaining contextual issues, resolving contextual issues, discussing problem solving and comparing, and concluding learning materials.

PMR approach applied in learning process has benefits in mathematical skills based on research, including: 1) improving the ability of critical thinking; PMR approach implementation in learning can overcome difficulties in solving mathematical critical thinking skill (Delina, 2018). 2) Improving creative thinking skills; Improving students' creative thinking in mathematics learning with PMR approach is better than improvement of students' creative skills learning with conventional approach (Iskandar, 2015). 3) Improving mathematical problem-solving skills; Students' mathematical problem solving skills with PMR approach significantly better than students who learn with conventional approach (Muchlis, 2012).

Based on descriptions, it demonstrates importance of higher order thinking skills in mathematics learning. The fact show that in mathematics learning higher order thinking skills need to be improved. Mathematics learning media are still rarely found especially designed using a learning approach to develop students' higher order thinking skills. This demonstrates the importance of developed learning media by using a suitable learning approach to develop higher order thinking skills. Because research is done to develop mathematics learning device using realistic mathematical education approach to improve learners' higher order thinking skills.

2. Methodology

This research was a research development. Product of this development study was a learning mathematics media using a realistic mathematical education approach for students of grade VIII Junior High School. The Media that was developed are syllabus, learning implementation plan (RPP) and student's activity sheet (LKPD), and higher order thinking skills test instrument. Development model used in the study was ADDIE model developed by Sugiyono.

This research was held in September 2019 at Al-Fityah Islamic Junior High School. The test subjects in this study were teachers and students grade VIII. The subject of limited test was chosen randomly from class IX 9 students. On field test were students of VIII A class. In effectiveness test were students of VIII B class.

The development procedures in this study referred to five phases: analysis, design, development, implementation, and evaluation. In analysis stage, it was conducted several analysis activities as a reference to initial product design, namely: 1) needs analysis, 2) analytical characteristics of students, 3) learning materials analysis.

At design stage, it conducted several activities, researcher designed the learning media in syllabus, RPP, LKPD and test instrument. Higher order thinking skills. At development stage researcher conducted two activities: developing learning media and conducting expert test.

At implementation stage, two test, limited and field test have been conducted. The last stage was evaluation activity. Learning media evaluation was done since development stage was validity of learning media evaluation by experts, limited test time evaluation, and field test evaluation.

Data collection technique in this study was non-test technique. Non-test techniques were conducted through provision of validation sheets, student assessment sheets, and learning-management observation sheets. The instruments used in this study including validation sheets, teacher's assessments, and students' assessments. Data analysis techniques in this study were validity analysis and practicality analysis.

3. Results and Discussion

In developing learning media, format selection was performed. Format options are adjusted to PMR approach steps. Then format of each media was developed. When finished, learning media was validated by validator and continued with test. The following is cover images of revised LKPD (Figure 1).



Figure 1. The screen shot of developed LKPD

Experts Data Test Results

The initial product learning media are developed in validation by experts to see quality of the product reviewed from the content. Media learning validation is performed by three experts by rating syllabus, RPP, LKPD, and test instruments measuring *HOTS*.

The assessment of validator on syllabus including identity aspects, KI and KD, IPK formulation, learning materials, learning activities, learning evaluation, time allocation, and learning sources. Data analysis validation results by validators on syllabus can be seen in table 1

Tabel 1. Validation Result on Syllabus

No	Indicator	Average	Criteria
1	Syllabus's Identity	3,83	Very Valid
2	KI and KD	3,89	Very Valid
3	IPK Formulation	3,50	Very Valid
4	Learning Materials	3,67	Very Valid
5	Learning Activities	4,00	Very Valid
6	Learning Evaluation	3,89	Very Valid
7	Time Allocation	3,83	Very Valid
8	Learning Source s	3,83	Very Valid
Average		3,81	Very Valid

The validator assessment results indicate each syllabus component has a very valid category with average value 3.81 is in a very valid category meaning syllabus developed is valid for test.

Validator assessment on RPP covers identity, CC and KD, IPK formulation, learning objectives, learning materials, learning activities, learning evaluation, time allocation, learning sources, and language. The results of data analysis validation by validators on RPP can be seen in table 2.

Table 2. RPP Validation Result

Rated Aspect	Average	Category
Identity	4,00	Very Valid
KI and KD	3,83	Very Valid
IPK Formulation	3,47	Very Valid
Learning Objectives	3,54	Very Valid
Learning Materials	3,50	Very Valid
Learning Activities	3,67	Very Valid
Learning Sources	3,38	Valid
Learning Evaluation	3,33	Valid
Time Allocation	3,56	Very Valid
Language	3,97	Very Valid
Rata-rata	3,62	Very Valid

Validation result on RPP as a whole obtained an average value of 3.62 in a very valid category, meaning RPP is developed using PMR approach to improve higher order thinking skills is valid for test.

Validator assessment of LKPD including content aspects, language eligibility, student activity eligibility, time allocation, engagingness, and components. The results of data analysis validation by validators on LKPD can be seen in table 3.

Table 3. LKPD Validation Result

Rated Aspect	Average	Description
Content	3,51	Very Valid
Language Eligibility	3,39	Valid
Student Activity Eligibility	3,62	Very Valid
Time Allocation	3,11	Valid
Engagingness	3,43	Sangat valid
Components	3,98	Sangat valid
Average	3,51	Sangat valid

According to table 3 validation results on LKPD, overall obtaining an average value 3,51 is in a very valid category, meaning LKPD uses a PMR approach to improve higher order thinking skills developed is valid for test.

Validator assessment on learning-outcome test instruments measuring *HOTS* covers aspects of materials, contingency, and language. Validation results of test instruments from validator can be seen in table 4.

Table 4. *HOTS* Questions Validation Result

No Question	Rated Aspect				Description
	Material	Construct	Language	Average	
1	3,75	3,42	3,75	3,64	Very Valid
2	3,53	3,40	3,58	3,51	Very Valid
3	3,47	2,98	2,75	3,07	Valid
4	3,47	3,23	3,50	3,40	Valid
5	3,60	3,47	3,50	3,52	Very Valid
6	3,67	3,80	3,25	3,57	Very Valid
7	3,60	3,60	3,17	3,36	Valid
Average	3,58	3,41	3,36	3,45	Very Valid
Description	Very Valid	Very Valid	Valid	Very Valid	

Based on table 4. Learning test instruments validation results measuring HOTS. Obtaining an average value 3.45 in very valid category, meaning learning test instrument measuring HOTS is valid for test.

Limited Data Test Results

After validation, researcher calculate and analyze validation results of learning media in the form of syllabus, RPP, LKPD, and learning test instruments measuring HOTS. Researcher also improved learning media developed according to the advice of validator. Product that has been validated and revised further is a limited test to determine the media legibility. Test was conducted on 9 students who have different abilities taken from students of class IX Al-Fityah Islamic Junior High School Pekanbaru. Limited test results of developed LKPD can be seen in the following table 5.

Table 5. Student's Questionnaire Result on LKPD Readability

Aspect	Average	Description
Content Eligibility	3,43	Very Practical
Language Eligibility	3,53	Very Practical
Activities Eligibility	3,45	Very Practical
Time	3,26	Practical
Engangingness	3,35	Practical
Average per LPKP	3,41	Very Practical

Based on table 5. Students' response to readability of LKPD overall obtained an average value 3.41 in a very practical category. This means LKPD readability developed is "very practical".

Practicality Data Test Results

Learning media products that have been conducted expert test and limited test then carried out field test. The selected trial class is class VIII A Al-Fityah Islamic Junior High School Pekanbaru. Field test is to see practicality of learning media developed. The results of field trials consist of two, teacher's activity observation

sheet result and the student's questionnaire.

Teacher's activity observation sheet assesses some aspects such as preliminary activities, core activities and closing activities in learning process. Teacher activity observations sheet can be seen in table 6 below.

Table 6. Teacher Activity Observation Sheet Result

No	Rated Aspect	Average	Description
1	Prellimanry Activities	3,60	Very Practical
2	Core Activities	3,63	Very Practical
3	Closing Activities	3,61	Very Practical
Average		3,62	Very Practical

Based on table 6. Assessment result overall activity obtained average value of learning activity implementation sheet is 3.62 "very practical" criteria. This suggests the use of mathematical learning media with realistic mathematical approaches is carried out and can be used properly.

Students' questionnaire assesses some aspects such as content eligibility, language eligibility, activity eligibility, time, and engagingness. After learning activities completed students are given questionnaire to see LKPD practicality at each meeting. Student's questionnaire result can be seen in table 7.

Table 7. Students' Questionnaire on LKPD Practicality

No	ASPECT	Average	Description
1	Content Eligibility	3,46	Very Practical
2	Languange Eligibility	3,49	Very Practical
3	Activity Eligibility	3,47	Very Practical
4	Time	3,32	Practical
5	Engagingness	3,45	Very Practical
Average per LKPD		3,44	Very Practical

Based on table 7. Students' assessment result about LKPD practicality obtained an average value 3.43 in the category "very practical". This means that LKPD readability developed "very practical" is used by students.

4. Conclusion

Based on the results of this research and development, it obtained several conclusiobs. (1) Mathematics learning media products use PMR to develop HOTS of VIII junior high school students in VIII odd semester that has characteristics: a) Initiate learning mathematics with real problems. b) Using the model as a bridge between real and abstract can help students learning mathematics at abstraction level. c) Using students contributions or strategies, (d) Maximizing interactions between students, students, and students-learning resources. e) Associating mathematical materials with other mathematical topics (intertwined). f) Developing students' HOTS. (2) Learning media final product meets validity

criteria and with the average score of the validator's assessment on very valid category. (3) Learning media final product meets the practical criteria with the average student rating in very practical category, teacher rating in very practical category.

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