Developing Mathematics Module based on Realistic Mathematics Education (RME): Triangle Topic for 7th grade of Junior High School

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Abstract. Student problem in mathematics learning is understanding the abstract mathematical material and real problem in daily life. Therefore, this research aims to produce mathematics module with triangle topic for Junior High School at 7th grade based on Realistic Mathematics Education (RME) which valid and effective for the process of learning and find out students positive response to the module. The module was arranged based on realistic mathematics education for emphasizing that module can help students reach more understanding through real context or real mind which concern in vertical mathematization and horizontal mathematization. The method of this research was research and development (RnD). This module contained real context topic which served on students activities, summary, exercises in every subtopic and final evaluation.

Keywords: mathematics module, realistic mathematics education, triangle.

1 Introduction

Education in Indonesia is increasingly leading to a better system. The 2013 curriculum aims to meet the demands of the times in building a life that comes from national culture, which is developed on the basis of the population dynamics needed and embodies education that revolves around its psychological development. Therefore, authentic learning is the recommended technique for mastering secondary school subject matter. Authentic learning is learning that allows students to search, discuss, and construct meaningfully the concept of relationships that involve real problems that are relevant to students.

At present, there are three solved problems in mathematics education, namely mathematics curriculum material, teaching methods and assessment approaches. One promising approach to mathematics teaching and learning that is considered to overcome this problem is Realistic Mathematics Education (RME) [1]. RME is one promising approach because it uses real problems. The success of RME is well-designed textbooks supported. The students should develop their mathematical understanding by working from contexts that make sense to them[2].

Implementation of the Learning Process Rules explains that one of the rules is a textbook. Textbooks were used to improve the efficiency and effectiveness of learning adjusted to the needs of students. Textbooks are printed and published sources designed to be

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used by teachers and students in the learning process. Textbooks provide explanations and exercises for students to complete and offer instructional guides for teachers[3]. Therefore, textbooks also support the implementation of authentic learning.

Based on investigators' research on Junior High School mathematics textbooks, the subject matter presented tends to be abstract. Teachers in schools that apply the 2016 revised 2013 curriculum are able to use books for the learning process. However, the teacher only directs students to find formulas and use it on formal mathematical problems, but students do not understand the concept of use in real context problems. The teacher only directs students to do vertical mathematization, which is the form of developing formal mathematical concepts.

One of them happened in Santo Antonius Junior High School, East Jakarta. Mathematics teachers in this school must carry out the learning process using various types of source learning combined in their own way. Not infrequently, teachers are difficult to find a way so students can immediately learn based on daily life activities to achieve the meaningfulness of the concept. In addition, students use textbooks only to find out formulas and do exercises with similar questions. Students in St. Anthony Senior High School also assume that the language used in the textbook is quite difficult to understand. Thus, textbooks are less effective in helping students carry out the learning process according to the 2016 revised 2013 curriculum with or without teacher assistance.

One of the subject matter in a textbook is a triangle. At the beginning of the introduction of the triangle, the material contained in this book utilizes the environment of students so that students can understand the definition of a triangle. However, in other triangular discussions, the concept is given directly and then applied in daily life. The presentation was abstract. It is difficult for students to understand the concept. In addition, although everyday problems have been used to raise mathematical problems, in fact, it is difficult for students to imagine situations in real time and then process them through mathematical modelling.

Basically, mathematics starts with daily problems that are inherent in the activities of human life. Mathematics education has a starting point from the final results of the mathematician performance[4]. Mathematics education must begin at the point of departure because mathematics is an activity.

The close links create easy and efficient mathematics learning potential. This potential creates a process of horizontal mathematization which continues in the vertical one. Horizontal mathematization is the learning of mathematics based on concrete things from activities or real problems in the environment, whereas vertical one is the process of developing more formal mathematical concepts. The balance between the two processes occurs in the RME.

The meaning of the mathematical concept is the main part of the RME. Student learning process will occur if knowledge is meaningful to students[5]. The problems discussed in RME learning do not always have to be daily life problems, but learning that is able to create real conditions and students can imagine in his mind. In addition to understanding and being able to apply the concept, realistic mathematical education allows students to remember longer the formed concepts because the learning process comes from their experience.

Therefore, based on the explanation above, the researcher felt that there was a need to produce a module to complete the sourcebook for the learning process. The focus of this research is as follows: (a) to create mathematics module with triangle topic for Junior High School at 7^{th} grade based on RME that are suitable for use in Santo Antonius Junior High School; (b) to count the effectiveness of mathematics module with triangle topic for Junior High School at 7^{th} grade based on RME in Santo Antonius Junior High School; (c) to figure

out the students' responses about mathematics module with triangle topic for Junior High School at 7th grade based on RME in Santo Antonius Junior High School.

2 Research method

The method of this research is research and development. It was divided into 4 levels as follows : (1) research without testing; (2) testing without research; (3) research and test to develop an existing product; (4) research and test for creating the product that has not exist before. This research refers to 4th level research and development[6]. However, researcher restricted this research until the 2nd revision of the product in order that produces the final product. So, the process of this research showed in Fig. 1

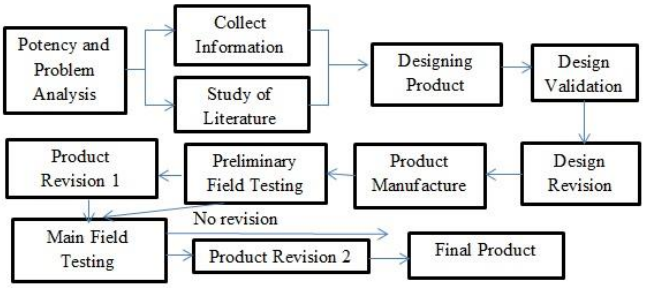

Fig. 1. Process of 4th level research and development in this research.

Steps of this research were divided into 2 big groups. First, the research step includes potency and problem analysis, collect information and study of literature. Second, development step includes designing product, design validation, design revision, product manufacture, preliminary field testing, 1st product revision, main field testing, 2nd product revision, and final product. This research will focus on Santo Antonuis Junior High School in East Jakarta.

2.1 Potency and problem analysis

This step will use a qualitative method. It is an interview. The researcher will interview mathematics teacher to find outfield facts about obstacle and problem found. This interview will be held semi-structured.

2.2 Collect information and study of literature

The researcher needed a study of literature to produce a product. In this phase, the researcher made curriculum analysis and technology analysis which necessary to make the product.

2.3 Designing product

This step was designing a product that appropriate with potency and problem analysis. The researcher will use software Microsoft word for content and software Adobe Photoshop CS3 for cover.

2.4 Design validation

After designing of product, the next step was designing validation. There were three validators. They are a mathematics teacher and two lecturers of mathematics education department.

The questionnaire was given to expert validator during the validation by experts. This instrument used differential semantics in the form of a rating scale. Four indicators adapted from BSNP in the instrument are the feasibility of content, presentation, linguistics, and graphics[7]. The researcher also added an indicator which is characteristic of Realistic Mathematics Education. Then, the researcher analyzed the data quantitatively after all validators fill out the questionnaire and provide criticism and suggestions. Calculation of scores was done by converting scores to standard values of five scales along with guidelines for converting quantitative into qualitative data[8].

Table 1. Guidelines for converting score to the standard value of five scales.

Score interval	Category
$M_i+1.5\ SD_i < x$	Very valid
$M_i + 0.5\ SD_i < x \leq M_i + 1.5\ SD_i$	Valid
$M_i - 0.5\ SD_i < x \leq M_i + 0.5\ SD_i$	Quite valid
$M_i - 1.5\ SD_i < x \leq M_i - 0.5\ SD_i$	Less valid
$x \leq M_i - 1.5\ SD_i$	Very less valid

Then the value is replaced in Table 1, so we get a guide for converting quantitative into qualitative data as table 2. While data of criticism and suggestion from validators are analyzed qualitatively as a consideration for the researcher to revise the product.

Table 2. Guidelines for converting score to the standard value of five scales.

Score interval	Category
$4 < x$	Very valid
$3.33 < x \leq 4$	Valid
$2.67 < x \leq 3.33$	Quite valid
$2 < x \leq 2.67$	Less valid
$x \leq 2$	Very less valid

2.5 Design revision

The researcher revised product design according to the critics and suggestions of the validator analyzed. Design revisions were made to get the best product design before making the product for field testing.

2.6 Product manufacture

After the researcher got the maximum design, then the product was made by printing the design on B5 size paper and bound by the soft cover.

2.7 Preliminary field testing

Initial field testing with the limited scale was in the form of testing mathematical modules with triangular topics for SMP at 7^{th} grade based on (RME). This stage uses a 6-12 subject or student. The subject was the student of Junior High School at 8^{th} grade who have studied triangle topic. A pretest was given to the student before the module is applied. After knowing the students' initial abilities, the student learns the triangle topic again using the module during 5 hours of the lesson (5×40 minutes = 200 minutes). The experimental method used to determine the effectiveness of the product is one group pretest-posttest. There were 2 types of instrument in this stage. There were the test and non-test instrument. The test instrument is pretest and posttest. The non-test instrument is a questionnaire.

2.8 1^{st} product revision

Product revisions are carried out by researchers by looking at users' opinions in preliminary field testing. However, the module can be used on the main field if the opinion is positive.

2.9 Main field testing

Researcher retested mathematical modules with triangular topics for Junior High School at 7^{th} grade based on RME in the main field testing. Maintenance in the main field test is similar to the initial field testing. The experimental method used to determine product effectiveness is one group pretest-posttest. There were 2 types of instruments at this stage, namely test and non-test instruments. The test instruments were pretest and posttest. The non-test instrument was a questionnaire.

2.10 2^{nd} product revision

Product revisions are carried out by researchers by looking at users' opinions in main field testing. However, the module is the final product if the opinion is positive.

2.11 Final product

The process of this research only until product revisions by looking at users' opinions in main field testing. If the module was valid and effective, the last product revision is the final product of this research.

3 Result and discussion

3.1 Research phase

First, the researcher analyzed the result of interviews with mathematics teacher through problem analysis. The problems presented by the teacher relate to students' reasoning and understanding. The reality of students ability which is still low on triangle topic encouraged the researcher to look for potential learning to be able to help the learning process in these conditions. Researchers began to introduce RME through mathematical modules. This step answers the needs of books that can be used directly by students. Then, the next step is to collect information and study literature. Collecting information and literature studies were carried out in the form of curriculum and technology analysis. In curriculum analysis, the researcher will produce mathematical modules in accordance with the conditions or demands of the 2013 revised curriculum. While technical analysis is carried out due to the making of mathematical modules that involve computer technology to design products.

3.2 Development phase

The product is mathematics module with triangle topic for Junior High School at 7th grade based on RME printed in 2 versions are student edition and teacher edition. The module size who chosen by the researcher is the B5 paper size or 182×257 mm. The mathematics module student edition that researcher design consists of cover, preface, basic competence, module completeness, table of contents, list of images, opening page, mind map, triangle lesson material, final evaluation and bibliography. While, the mathematics module teacher edition that researcher design consists of cover, preface, basic competence, module completeness, table of contents, list of images, opening page, mind map, triangle lesson material, teacher's guide, final evaluation, answer key and bibliography.

A product is suitable for use if an expert validated the product. Criticism and suggestions for improvement are used researcher for revision of the product. Based on the result of the expert judgement of the module, the result of the assessment score analysis is as Table 3.

Table 3. Validator assessment score.

No.	Aspect	Mean	Category
1.	Feasibility of content	3.98	Valid
2.	Presentation	4.48	Very valid
3.	Linguistic	4.25	Very valid
4.	Graphics	4.87	Very valid
5.	Characteristics of Realistic Mathematics Education	4.1	Very valid

Based on table 3, the results are in the form of mathematical modules with triangular topics for Junior High School at 7th grade based on valid RME tested in the preliminary and main field after being revised according to criticism and suggestions from the validator to produce a design that is considered perfect.

In the initial field testing, the researcher applied the module during the learning process for 11 students 8th grade. Students took the pretest before the learning process began. Students

took the posttest after the learning process using the math module and filled out the student response questionnaire about the mathematics module with the triangle topic for Junior High School at 7th grade based on the RME. The pretest and posttest data obtained from the preliminary tests were normal. Furthermore, hypothesis testing was done by SPSS through t-test related.

The statistical score showed that t-count is 6.237, t-table with $dk = 10$ and $a = 0.05$ is 1.812. The SPSS results showed that the t-count value was higher than t-table. In addition, the probability value in SPSS obtained $0.000 < 0.005$ which means a rejection of H_0 and the value of learning outcomes after using mathematical modules with triangular topics for junior high school at 7th grade based on RME was higher than student learning outcomes before using the module. We can see that the average value of posttest is significantly higher than the average value of the pretest before using the module.

The result of the questionnaire analysis of student responses in preliminary field testing to module obtained percentages as in Table 4.

Table 4. Percentages of student positive response in preliminary field testing.

No.	Aspect	Mean	Category
1.	Feasibility of content	80.23%	Positive
2.	Presentation	80.52%	Positive
3.	Linguistic	81.45%	Positive
4.	Graphics	80.73%	Positive
5.	Characteristics of Realistic Mathematics Education	78.79%	Positive
Mean		80.34%	Positive

The results of the comparative analysis of the pretest-posttest average and the student positive response questionnaire indicated that there was no revised module. Therefore, we can use the module the main field testing.

In the main field testing, eight students at 7th grade applied modules during the learning process. The student took the pretest before the learning process begins. They took posttest after the learning process using the math module and fill out the student response questionnaire about the mathematics module with the triangle topic for junior high school at 7th grade based on the RME. The pretest and posttest data obtained were not normal. Furthermore, hypothesis testing was done by SPSS through t-test related.

The statistical value shows that the negative rating is 0. Whereas, with $n = 18$ and $a = 0.05$, it is 40, which means acceptance of H_a and rejection of H_0. That means the value of learning outcomes after using mathematical modules with triangular topics for junior high school at 7th grade based on RME higher than student learning outcomes before using the module.

The result of the questionnaire analysis of student responses in preliminary field testing to module obtained percentages as in the Table 5.

Table 5. Percentages of student positive response in main field testing.

No.	Aspect	Mean	Category
1.	Feasibility of content	79.31%	Positive
2.	Presentation	78.41%	Positive
3.	Linguistic	79.56%	Positive
4.	Graphics	80.22%	Positive
5.	Characteristics of Realistic Mathematics Education	80.37%	Positive
Mean		79.57%	Positive

The results of the comparative analysis of the pretest-posttest average and the student positive response questionnaire indicated that there was no revised module. Therefore, the researcher suggested that the Junior High School of Saint Anthony uses mathematical modules with triangular topics for SMP at 7th grade based on RME for the learning process.

3.3 Analysis of student achievement

This research produced a valid and effective mathematical module with triangular topics for SMP at 7th grade based on RME. Students in the initial field and main field test have responded positively. However, the researchers found that students' scores from pretest to posttest increased but not all students achieved the minimum completeness criteria. Therefore, the researcher then calculated the data acquisition to find an increase in students' abilities.

After calculating the initial and main field test data, the results were students who have high, medium, and low abilities. However, the increase was not in line with achievement. Therefore, researchers conducted a N-gain calculation to determine student achievement when viewed from the data of students' previous mathematical knowledge. The data obtained comes from student report cards at 7th grade semester 1. Grouping students based on their initial mathematical knowledge determined as in Table 6.

Table 6. Grouping student based on mathematics prior knowledge.

Score interval	Category
MPK $\geq$ mean + s	High group students
Mean – s < MPK< mean + s	Medium group students
MPK $\leq$ mean + s	Low group students

description :
s = standard deviation
MPK = Mathematics Prior Knowledge

After that, the calculation of N-gain data is done to determine student achievement after using a mathematical module with triangular topics for Junior High School at 7th grade based on RME. N-gain is determined based on Table 7.

Table 7. Criteria of N-gain score.

N-gain score	Category
N-gain $\geq$ 0.70	High achievement

N-gain score	Category
0.30 < N-gain < 0.70	Medium achievement
N-gain ≤ 0.30	Low achievement

The third acquisition of these data helps researchers search for facts about student achievement based on mathematics prior knowledge.

Preliminary field testing. N-gain data in the preliminary field test showed that 27.27% of students had high achievements, 36.36% of students had moderate achievements, and 36.36% had low achievements.

Main field testing. N-gain data in the main field test showed that 27.78% of students had high achievement, 11.11% of students had moderate achievement, and 61.11% of students had low achievement.

3.3 Analysis of student achievement based on mathematics prior knowledge

Then, the researcher tried to analyze student achievement based on mathematics prior knowledge, obtained the following result as shown in Table 8 and Table 9.

Table 8. Student achievement based on mathematics prior knowledge in preliminary field testing.

MPK Category	Statistic data	Pretest	Posttest	N-gain
Low	Mean	23.5	43.5	0.28
	s	10.61	26.16	0.24
	Amount of student		2 persons	
Medium	Mean	34.5	60.39	0.44
	s	14.99	23.48	0.31
	Amount of student		7 persons	
High	Mean	65.75	94.5	0.80
	s	18.74	0.71	0.13
	Amount of student		2 persons	
Ideal maximum score = 100				

Table 9. Student achievement based on mathematics prior knowledge in main field testing.

MPK Category	Statistic data	Pretest	Posttest	N-gain
Low	Mean	1	12.33	0.11
	s	0	4.19	0.04
	Amount of student		3 persons	
Medium	Mean	16.23	51.23	0.43
	s	11.98	28.64	0.31
	Amount of student		13 persons	
High	Mean	54	86	0.73
	s	14.14	13.44	0.21
	Amount of student		2 persons	
Ideal maximum score = 100				

Both results of the calculation give the same result, as follows :

In the low mathematics prior knowledge category group, student achievement is also low after using mathematics module with triangle topic for Junior High School at 7th grade based on RME.
In the medium mathematics prior knowledge category group, student achievement is also low after using mathematics module with triangle topic for Junior High School at 7th grade based on RME.
In the high mathematics prior knowledge category group, student achievement is also high after using mathematics module with triangle topic for Junior High School at 7th grade based on RME.

So, the result is mathematics module with triangle topic for Junior High School at 7th grade based on RME will provide high achievement result when used for students with high mathematics prior knowledge categories.

4 Conclution

Mathematics module with triangle topic for Junior High School at 7th grade based on RME is valid and effective for learning. This module also got a positive response from students in preliminary field testing and main field testing for all aspect. Therefore, the researcher suggested that the Junior High School of Saint Anthony uses mathematical modules with triangular topics for SMP 7th grade based on Realistic Mathematics Education (RME) for the learning process.

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