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Developing Teaching Material Based on Realistic Mathematics Andoriented to the Mathematical Reasoning and Mathematical Communication

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Abstract

This research aims to produce mathematics textbook for grade VII junior high school students based on realistic mathematics and oriented to the mathematical reasoning and mathematical communication. The quality is determined based on Nieveen (1999) criteria, including validity, practicality, and effectiveness.This study was a research and development and used Borg & Gall model. The subject of this research were the students of SMPN 2 Pujon-Kabupaten Malang, that is 30 students in an experimental class (using the developed textbook) and 29 students in a control class (using BSE book from the government). The teaching material was categorized valid if the expert's judgment at least is categorized as “good”. The teaching material was categorized practical if both of teachers and students assessment at least categorized as “good”. The teaching material was categorized effectively if minimum 75% of student scores at least is categorized as “good” for the mathematical reasoning test and mathematical communication test. This research resulted in a valid, practical, and effective teaching material. The resulted of the validation show that material teaching is valid. The resulted of teachers and students assessment show that the product is practical. The tests scores show that the product is effective. Percentage of students who categorized at least as “good” is 83,33% for the mathematical reasoning and 86,67% for the mathematical communication. The resulted of statistic test shows that the product more effective than the BSE book from the government in terms of mathematical reasoning and mathematical communication.

Keywords: teaching material, realistic mathematics education, mathematical reasoning, mathematical commnunication

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INTRODUCTION

Mathematical reasoning and mathematical communication are two essential competencies that must be owned by the students. Two of these competencies is the purpose of learning mathematics so that it is proper that these two abilities have received special attention in the study of mathematics, without neglecting the other abilities of the students. Mathematics is close to reasoning skill. Ball and Bass (Brodie, 2010, p. 8) said that reasoning is a “basic skill” of mathematics and is necessary for a number of purpose-to understand mathematical concept, to use mathamatical ideas and procedures flexibly, and to reconstructonce understood, but forgotten mathematical knowledge. According to the (The National Council of Teachers of Mathematics, 2000, p. 262), high school students should have-varied experience on mathematical reasoning such as to evaluate conjecture, to develop and evaluate mathematical arguments. The experience will help students to improve their ability to analyze mathematical problems. This means that at the high school, students should have a good ability in mathematics. In line with this, Byrnes (2008, p. 295) explains that Instructional Programs from pre-kindergaten through grade 12 should enable all students to recognize reasoning and proof as fundamental aspects of mathematics; make and investigate mathematical conjectures; develop and evaluate

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mathematical arguments and proof; select and use various types of reasoning and methods of proof. The argument is evidence, part of the reasoning that aims to convince themselves or others that exact reasoning (Boesen, Lithner, & Palm, 2010, p. 92) .

Likewise et. al (2014, p.27) found a way to improve students' reasoning is to discuss the argument that incorrect or invalid. An invalid argument would encourage reasoning that vary from students and can eliminate misunderstanding. Based on the opinion of several experts in the above, it can be concluded that the reasonig skills include the ability to find a mathematical pattern of symptoms, the student's ability to make a conjecture, and the student's ability to evaluate the validity of a mathematical argument.

Apart to reasoning skills, the purpose of learning mathematics also to develop mathematical communication skills. Such capabilities include the ability to communicate ideas with oral conversations, notes, symbols, charts, graphs, diagrams, or other media to clarify the situation or problem. Mathematical communication is an essential part of mathematics and mathematics education (The National Council of Teachers of Mathematics, 2000, p. 60). Communication can occur when the student took his idea and explaining the models found to the problems presented.

In mathematics, communication can be used to share ideas and build an understanding of a concept. (Hirschfeld-Cotton, 2008, p. 4) showed that after the students communicate their ideas, teachers have a better understanding about their students. Teachers will be more confident that the students have prepared given standard tests and can demonstrate an understanding of a concept.

Communication is a form of expression in mathematics, it is as described in the curriculum of Ministry of Education (2007, p. 22) that "communication is the process of expressing mathematical ideas and understandings orally, visually, and in writing, using numbers, symbols, pictures, graphs, diagrams, and words". Based on the opinion of several experts in the above, it can be concluded that some mathematical communication skills is the ability of students to express ideas visually, the ability of students in interpreting a visual representation, and the student's ability to give a reason to the ideas.

Mathematical reasoning and communication are expected to be the basic competencies that students need to have in learning mathematics. There was a significant relationship between mathematical communication and mathematical reasoning abilities of students with the basic competence achievement of mathematics. If the mathematical reasoning and mathematical communication ability are low, consequently achieving basic competencies of students will be low and vice versa. This shows that both these capabilities should receive special attention in the study of mathematics, without ignoring other mathematical abilities of the students.

In fact, Indonesia’s students mathematical reasoning ability is still low. It is based on learning outcomes research at the international level organized by Trends In International Mathematics and Science Study (TIMSS) conducted every four years in grade four and eight. The percentage of Indonesia's students results in TIMSS 2011 for each cognitive domains compared with other countries can be seen in Table 1.

Table 1. Average Correct Problem in TIMSS 2011 (%)

Country	***Knowing***	***Applying***	***Reasoning***
Singapura	82 (0,8)	73 (1,0)	62 (1,1)
Korea Ref.	80 (0,5)	73 (0,6)	65 (0,6)
Jepang	70 (0,6)	64 (0,6)	56 (0,7)
Malaysia	44 (1,2)	33 (1,0)	23 (0,9)
Thailand	38 (1,0)	30 (0,8)	22 (0,8)
Indonesia	31 (0,7)	23 (0,6)	17 (0.4)
Int. average	49 (0,1)	39 (0,1)	30 (0,1)

Resource: (Mullis, Martin, Foy, & Arora, 2012, p. 462)

Average ability Indonesia’s students in each domain is still far below the international average. The lowest average at the cognitive reasoning is 17%. The TIMSS results show that the reasoning abilities of Indonesia’s students is still low.

The low ability of mathematical reasoning and communication are also strengthened by the results of research interviews with some of the mathematics teacher who joined the Mathematics MGMP’s in district of Malang. Interviews showed that the ability of mathematical reasoning and communication and other mathematical ability has not been much attention in learning activities at the classroom. This indicates that the ability of students mathematical reasoning and communication has not been properly accommodated.

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Low ability of mathematical reasoning and communication due to the learning of mathematics in Indonesia mostly oriented towards the mastery of basic skills and very little emphasis in the context of everyday life, communicating mathematically and reason mathematically (Shadiq, 2007, p. 2). Learning mathematic are more likely on target achievement-oriented material and exam questions. It is known from the survey of IMSTEP-JICA (Herman, 2007, p. 42), which indicates that the low quality of student understanding in mathematics because teachers are too concentrated on procedural matters and mechanistic as teacher-centered learning, mathematic concepts are often delivered is informative, and students are trained solve a lot of problems without a deep understanding. As a result, a variety of mathematical ability of students do not develop properly. Therefore, education should pay more attention to the ability of the students, not only oriented to the achievement of the target material. This is a task of the educational, one of whom is a teacher. Teachers are expected to choose the right learning approach in order to achieve the learning objectives completely.

Learning mathematics should begin with an introduction to the situation (contextual problem). By filing a contextual problem, learners guided to master mathematical concepts (Menteri Pendidikan Nasional, 2006). One of the learning approach that departs from contextual problems and are considered effective for improving mathematical abilities, especially the ability of mathematical reasoning and communication is realistic mathematics. RME offers more than a way to support students' understanding of an abstract to the concrete. RME instructional sequences are conceived as “learning lines” in which problem contexts are used as starting points to elicit students’ informal reasoning (Webb, van der Kooij, & Geist, 2011, p. 48).

RME or Realistic Mathematics Education was developed on the basis of the statement Freudenthal (1972, p. 134) that "mathematics is an activity". This is in line with the opinion of Treffers (Makonye, 2014, p. 656) argue that RME is a teaching and learning theory that views mathematics as a human activity that is connected to reality. Activities referred to here include solving problems, looking for problems, and organize a problem. Arsaythamby & Zubainur (2014, p. 310) found PMR is stresses that teaching and learning aids should be related to students’ daily lives and experiences. Learning mathematics is more effective if students work towards processing and transforming information, actively. Gravemeijer (1994, pp. 90–91) says there are three main principle in realistic mathematics approach, namely: (1) Guided reinvention and progressive mathematizing; (2) didactical phenomenology; and (3) Self-developed models. As the operationalization of three principles above, Treffers (Cowan, 2006, p. 20) formulates five characteristics of a realistic approach, that are the use of context that are “real” to the pupils, the use of models to allow for shifts to higher levels of understanding, the use of the pupils own mathematical constructions, the interactive natureof the teaching process – a partnership between the pupils and the teacher, and the entwining of various learning strands.

Realistic mathematics approach is believed to facilitate the 'mathematical reasoning and communication, this is based on the research of Asmida (2011, p. 1) concluded that learning with realistic mathematics effective to improve mathematical reasoning and communication. Similarly to the research conducted by Zaini & Marsigit (2014, p. 152) which showed that realistic mathematics approach is better than the conventional learning is reviewed on the aspects of mathematical reasoning and communication in grade VII SMP Negeri 15 Banjarmasin. Research from Setiani (2013, p. 266) shows that the assessment is based on realistic mathematics approach can improve the quality of mathematics learning process and results. Wahidin & Sugiman (2014, p. 108)Wahidin & Sugiman (2016, p.108) states that the RME is effective in terms of achievement motivation, but is not effective in terms of problem solving skills, and learning achievement. There is a significant difference between students who take the RME leaning than students who followed the conventional learning in terms of learning achievement, problem solving ability, and achievement motivation. RME gives a better effect in improving achievement motivation, problem solving skills, and student achievement.

There are two important issues that are the core of realistic mathematics that is mathematics should be connected with reality and mathematics should be viewed as a human activity. Contextual issues are used as a starting point in learning mathematics to help students develop an understanding of the mathematical concepts. Hadi (2005, p. 36) states that the

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concept of PMR in line with the need to improve mathematics education in Indonesia is dominated by the question of how to improve students' understanding of mathematics and how to develop the mathematical reasoning.

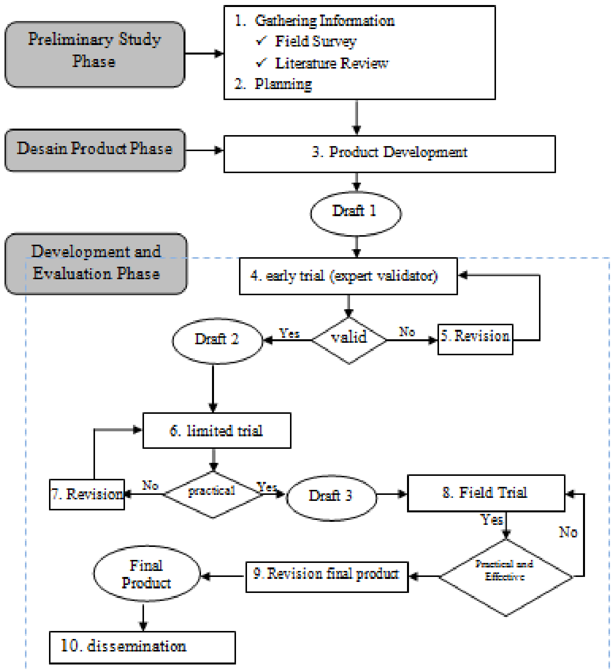
At the realistic mathematics learning, the teacher's role is as a facilitator, providing scaffolding in interpreting the real world, and associate mathematics curriculum with the real world. Based on the role of the teacher, then the teacher make preparations before doing the learning because it will affect the success of learning. Preparation that teachers can do is to prepare the learning material that will be used in teaching, one form of learning material is the book. However, the existing books and used in schools today cannot facilitate the mathematical competencies. This is supported by research Wijaya, van den Heuvel-Panhuizen, & Doorman (2015, p. 41) that showing the majority (85%) questions in mathematics textbooks in Indonesia including Electronic School Book (BSE) more focused on the procedural capabilities, and only about 10% of the problems require mathematical modeling. Therefore, teachers must be able to choose the right book to facilitate the development of students' mathematical abilities.

The fact on the field is a book that is used in the learning process did not facilitate a wide range of students' mathematical abilities, especially the ability of mathematical reasoning and communication. This fact is based on observations and interviews conducted by researchers at SMPN 2 Pujon. Moreover, not many teachers who create their own teaching materials especially teaching materials that facilitate communication and mathematical reasoning abilities. Aside from teaching materials, the learning process tend to be passive and less grain given problem within the context of everyday life so it is still considered to be difficult for students. In general, learning of mathematics still consists of the following series of events: early learning begins with the grain problem of the teacher, then performed a demonstration of resolving the problem, and finally the teacher asks the students to practice problem solving. Looking at the circuit, the students have not been thoroughly involved in learning so that students tend to be passive and silent, as a result of knowledge, understanding, and mathematical abilities were not accommodated properly.

According to the description above, this research aims to produce mathematics textbook for grade VII junior high school students based on realistic mathematics and oriented to the mathematical reasoning and mathematical communication that is validity, practicality, and effectiveness.

METHOD

This study is research and development in the field of education that aims to produce teaching materials in the form of mathematics textbooks for junior high school students of class VII Semester with realistic mathematics education oriented to the mathematical reasoning and communication. Research conducted at SMP Negeri 2 Karangploso, Malang. The development model used in this study was adapted from the Borg & Gall (1983, p. 775) that the procedure consists of ten steps. In general, the implementation of the ten steps of the Borg & Gall, grouped in three phases: a preliminary study, design product, and development and evaluation. The flow of research and development can be illustrated in the Picture 1.



Picture 1. Research and Development Flow

Subject to limited research involving nine students who were randomly selected from the category of high, medium, and low student ability. While the subject field research involves two classes, the class for the textbooks were developed and class as the control class. There are 30 students at trial class, and 29 students at control class. The type of data in this study consisted of quantitative data and qualitative

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data. Data collection instrument in this study consisted of: (1) the validation sheet, (2) teacher assessment questionnaire, (3) student assessment questionnaire (4) the evaluation instrument that consists of a test of mathematical reasoning and mathematical communication test.

The data analysis in this study aims to answer research questions about the validity, practicality, and effectiveness of the products developed. Data in the form of comments and suggestions were analyzed qualitatively, which is then used as inputs to revise the product developed. While the data obtained through the validation sheet, teacher assessment sheet, student assessment sheets, mathematical reasoning and communication tests were statistically analyzed descriptively.

The data is converted into data in the form of a qualitative score with five categories. The reference conversion scores into five categories presented (Widoyoko, 2013, p. 238) in the following Table 2.

Table 2. Convertion Category Quantitative Data to Qualitative Data

Interval Score	Category
$x > \bar{X}_i + 1{,}8\ Sbi$	Very Good
$\bar{X}_i + 0{,}6\ Sbi < x \leq \bar{X}_i + 1{,}8\ Sbi$	Good
$\bar{X}_i - 0{,}6\ Sbi < x \leq \bar{X}_i + 0{,}6\ Sbi$	Good Enough
$\bar{X}_i - 1{,}8\ Sbi < x \leq \bar{X}_i - 0{,}6\ Sbi$	Not Good
$x \leq \bar{X}_i - 1{,}8\ Sbi$	Very Poor

Information:

$\bar{X}_i = \frac{1}{2}$ (max ideal score + min ideal score)

$Sbi = \frac{1}{6}$ (max ideal score – min ideal score)

Where, x = empirical score

$\bar{X}_i$ = ideal mean

Sbi = ideal standart deviation

Determining the validity of teaching materials based on the validity of the data in the form of assessment scores by experts in the validation sheet. The following ideal minimum scores, the ideal maximum score, $\bar{X}_i$, and *Sbi* of the validity of teaching materials.

Table3.Ideal Minimum Score, Ideal Maximum Score, $\bar{X}_i$, and *Sbi* for the validity

Item	Ideal Min Score	Ideal Max Score	$\bar{X}_i$	*Sbi*
35	35	175	105	23,3

From Table 3 obtained intervals to determine the validity of the categories of teaching materials as presented in Table 4.

Table 4.Validity Category

Interval	Category
$x > 147$	Very Good
$119 < x \leq 147$	Good
$91 < x \leq 119$	Good Enough
$63 < x \leq 91$	Not Good
$x \leq 63$	Very Poor

The teaching material is said to be valid if the average assessments of experts is at least "good" category. When not reached that category, the product need to be revised based on the input of experts.

In assessing the practicality, there are two data to be analyzed, teacher assessment and students assessment. The ideal minimum scores, the ideal maximum score, $\bar{X}_i$, and *Sbi* of the practically of teaching materials.

Table 5.Ideal Minimum Score, Ideal Maximum Score, $\bar{X}_i$, and*Sbi*for the practically

Item	Ideal Min Score	Ideal Max Score	$\bar{X}_i$	*Sbi*
12	12	60	36	8

From Table 5 obtained intervals to determine the practically of the categories of teaching materials as presented in Table 6.

Table 6.Practically Category

Interval	Category
$x > 50{,}4$	Very Good
$40{,}8 < x \leq 50{,}4$	Good
$31{,}2 < x \leq 40{,}8$	Good Enough
$21{,}6 < x \leq 31{,}2$	Not Good
$x \leq 21{,}6$	Very Poor

Teaching materials are said to be practical if the results of the assessment of teachers and students each at least reach "good" category.

The effectiveness of teaching materials can be seen from the results of tests of mathematical reasoning ability and mathematical communication ability test. Tests performed at the beginning and end of the research (pretest-posttest). Tests conducted in the beginning used to describe the beginning of the two class (trial class and control class) before being given a lesson. Meanwhile, in the final test is used to determine the ability of the students after a given learning.

Tables for effectiveness category refer to Table 7. The ideal minimum scores, ideal maximum score, $\bar{X}_i$, and *Sbi*of the effectiveness of teaching materials in terms of ability tests students' mathematical reasoning and communication.

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Table7.Ideal Minimum Score, Ideal Maximum Score, $\bar{X}_i$, and *Sbi* for the effectiveness

Item	Ideal Min Score	Ideal Max Score	$\bar{X}_i$	*Sbi*
6	0	100	50	16,67

From Table 7 obtained intervals to determine the effectiveness of the categories of teaching materials as presented in Table 8.

Table 8.Effectiveness Category

Interval	Kriteria
$x > 80$	Very Good
$60 < x \leq 80$	Good
$40 < x \leq 60$	Good Enough
$20 < x \leq 40$	Not Good
$x \leq 20$	Very Poor

Teaching materials are said to be effective if the percentage of the minimum number of students who are in the category of "good" is 75% on both of mathematical reasoning ability and mathematical communication test.

After seeing the percentage of achievement, effectiveness analysis also reinforced by seeing the difference in the average value of the trial class and control class. To see the difference between the average value of trial class and control class used statistical test on the value of pretest and posttest on a trial class and control class.

RESULTS AND DISCUSSION

Preliminary Study Phase

Two steps are carried out at the preliminary study stage, namely information gathering and planning. In step information gathering, namely activities carried out field surveys and literature. The field survey was conducted to obtain information on the circumstances and the availability of teaching materials used by teachers and students in the learning process of mathematics. The activities carried out in this stage include field observations and interviews with mathematic teachers The results of the field survey obtained information that the learning process is still centered on the teacher. Teacher started learning by directly providing materials that provide less opportunity for students to construct their own understanding about the material. In addition to the learning process, it is observed from the stage of this observation is that the teaching materials used in teaching only the textbooks provided by the government and the LKS from private publishers. Textbook contains material and practice questions, while LKS contains a summary of the material and a collection of matter that did not facilitate the ability of students' mathematical reasoning and communication. The availability of teaching materials that can activate students in the learning activities is still lacking.

Besides observation, other activities of the preliminary study are interviews with mathematics teachers and obtained results that the teacher had never given a test that demonstrates mathematical reasoning and communication ability, the teacher has not been implementing learning with RME and the teaching materials used by mathematical teachersonly textbooks from the government and from private publishers. A literature study in this research include the study of RME, the study of mathematical reasoning skills, the study of mathematical communication skills, as well as the study of the model of development of teaching materials.

The second step of this research is the planning. At this stage, plans are in developing teaching materials for research. The plan includes content analysis and material analysis. Based on the content standards in the 2006 Curriculum, Standards of Competence for junior high school students of grade VII even semester there are three Competency Standards. One Competency Standards for algebra and two Competency Standards for geometry. Each Competency Standards consists of several basic competencies that is described in the following Table 9.

There are several competencies that must be mastered students during the learning process. Based on the structure and scope of science related topics such competence, then in these materials prepared four chapters, namely the set, lines and angles, triangles, and rectangles. Of the four chapters were developed into some of the topics outlined in Table 10.

Product Design Stage

The next stage after the preliminary study stage is the stage of product design. At this stage, researchers conducted a preliminary design of the teaching materials developed in the form of textbooks. At the beginning of each chapter of the textbook always contain basic competencies and learning objectives. Furthermore, each chapter has a material explanation, example problems, exercises, summaries, and competency tests. In general, the results of the

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preliminary study stage and the product design stage can be described in the Table 11.

Product Development and Evaluation Stage

Validation of experts was conducted to determine the validity of the products have been developed. In detail, the assessment results of each product validators are presented in Table 12.

Table 9.Competency Standards and Basic Competency of Grade VII

Competency Standards	Basic Competences
Algebra 1. Using the concept of sets and Venn diagrams in problem solving	1.1 Understand and notations set, and presentation 1.2 Understand the concept of subsets 1.3 Conducting operations intersection, union, less (difference), and complement on the set 1.4 Representing sets with Venn Diagram 1.5 Using the concept of the set in problem solving
Geometry 2. Understanding the relationship line by line, the line at an angle, the angle at the corner, as well as determine its size	2.1 Determining the relationship between the two lines, as well as the amount and type of corner 2.2 Understanding the properties of angles formed when two lines intersect or two parallel lines intersect with another line 2.3 Painting corner 2.4 Dividing the corner
3. Understand the concept square and triangle and determine its size	3.1 Identify the properties of triangles based on sides and angles 3.2 Identify the properties of a rectangle, square, trapezoid, parallelogram, rhombus and kite 3.3 Calculating circumference and area woke up a triangle and a rectangle and use it in problem solving 3.4 Drawing triangle, high line, weightline, and axis lines

Table 10.The Topics in Each Chapter

No.	Bab	Topic
1.	Set	• The concept of Sets • Sets Relations • Sets Operation
2.	Lines and Angles	• Definition of lines and angles • Position the two lines • The relationship between the angle • Relationships angels on two parallellines that cut other lines
3.	Triangle	• The properties of triangles • Perimeter and area of triangle • Drawing high line, the line, line weight, and line on the triangular axis
4.	Quadrilateral	• Various rectangular • The properties of a rectangle, square, parallelogram, rhombus, kite, and trapezoid • Perimeter and area of a rectangle, square, parallelogram, rhombus, kite, and trapezoid

Table 11. Results of the Preliminary Study Stage and Product Design Stage

No.	Preliminary Study Stage	Product Design Stage
1.	Teachers never provides mathematical reasoning and communication	Compiled problems oriented reasoning and communication skills. These issues are given in "Ruang Eksplorasi" that is placed at the end of each chapter
2.	Teachers never implement RME	Given a context to be completed by students, providing opportunities for students to make modeling, contribute, discuss, and associate with one another topic. This activity was facilitated on the "Aktivitas Mandiri" and "Ruang Diskusi" that can be directly done in the students' books
3.	Textbooks that have so far only contains a description of the material and giving examples	Compiled a book which contains a description of the material, sample questions, exercises, independent activity, discussion, summary, competency testing, and exploration.

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Table 12.Validity Analysis

Validator	Total Score	Interval	Category
I	154	X > 147	Very Good
II	146	119 < X ≤ 147	Good
Total	300		
Average	150	X > 147	Very Good

Based on Table 12 it can be seen that the products meet the very good category. This means that products such as the development of mathematics textbooks with a RME isvalid.

Data analysis practicality includes two things, the results of teachers' assessment in Table 13 and student sassessment in Table 14.

Table13. Practically Analysis of Teachers' Assessment

No.	Teacher	Total Score	Interval	Category
1.	Teacher I	54	x> 50,4	Very Good
2.	Teacher II	52	x> 50,4	Very Good
	Total	106		
	Average	53	x> 50,4	Very Good

Table14. Practically Analysis of Students' Assessment

Class	Amount	Total Score	Average	Interval	Category
VII A	30	1544	51,47	x> 50,4	Very good

From Table 13 and Table 14, a teacher and student assesment of the teaching material developed each are in the very good category. This means teaching material is practical.

Then, it will be shown the data of effectiveness product in terms of the mathematical reasoning. On the pretest, none of the students from the trial classes and control classes were in both categories. It is claimed that the mathematical reasoning abilities of students in that two classes at the beginning of the learning is still low. The pretest results of mathematical reasoning skills of students in the trial class and control class are shown in the Table 15.

After doing the learning, mathematical reasoning skills of students in both classes increased. It can be seen from posttest results are presented in Table 16.

The mathematical reasoning test was consisted by three indicators namely finding a pattern of mathematical symptoms (A), creating a mathematical conjecture (B), and evaluate the mathematical argument (C). Detail result of the mathematical reasoning skills of students in each indicators is shown in Table 17.

Table15. Pretest Results of Mathematical Reasoning

Class	Amount	Average	Minimal in Good Categories	Percentage
Trial	30	28,06	0	0%
Control	29	27,87	0	0%

Table 16. Posttest Results of Mathematical Reasoning

Class	Amount	Average	Minimal in Good Categories	Percentage
Trial	30	71,94	25	83,33%
Control	29	64,37	22	75,86%

In Table 16, the minimum number of students who are in the good category is 25 student so the percentage reached 83.33%. While in the control class, the minimum number of students who are in the good category is 22 students so the percentage reached 75.86%. Meaning that can be brought from posttest results are on trial class, teaching materials with RME effective in terms of mathematical reasoning skills. Similarly, the control class, books BSE used effectively in terms of mathematical reasoning skills. This is because the percentage of the minimum number of students who are in the good category of these two classes each of more than 75%.

In Table 17, it is known that many students are minimal in a good categories for each indicator on the trial class (VIIA) has reached more than 75%, while the control class (VIIB) number of students in both categories indicator B has reached 75 %, however, to indicator A and C has lower than 75%. This means that the class VIIB, to find pattern and evaluate the validity of a mathematical argument is still not finished.

Then, it will be shown the data of effectiveness product in terms of the mathematical communication. On the pretest, a minimum number of students who are in the good category at trial classis 3.33%, while none in the control class. It is claimed that the mathematical reasoning skill of students in both of class at the beginning of the learning is still low due to minimal number of students who are in the good category yet reached 75%. Table 18 is the results pretest mathematical communication skills of students in the trial class and control class.

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Table 17. Posttest Results of Mathematical Reasoning in Each Indicator

No	Class	Amount	Students were Minimal in Good Categories in each Indicator			Percentage (%)		
			A	B	C	A	B	C
1	VII A	30	24	27	26	80	90	86,67
2	VII B	29	18	26	18	62,07	89,67	62,07

Table 18. Pretest Results of Mathematical Communication

Class	Amount	Average	Minimal in Good Categories	Percentage
Trial	30	40,56	1	3,33%
Control	29	41,38	0	0,00%

Table 19. Posttest Results of Mathematical Communication

Class	Amount	Average	Minimal in Good Categories	Percentage
Trial	30	77,50	26	86,67%
Control	29	70,11	22	75,86%

Table 20. Posttest Results of Mathematical communication in Each Indicator

No.	Class	Amount	Students were Minimal in Good Categories in each Indicator			Percentage (%)		
			A	B	C	A	B	C
1.	VII A	30	27	25	25	90	83,33	83,33
2.	VII B	29	21	21	23	72,41	72,41	79,31

After doing the study, the average value posttest mathematical communication skills in both classroom experiencing an increase. Post-test results of both classes can be seen in Table 19.

The mathematical communication test was consisted by three indicators namely express ideas visually (A), interpret a visual representation (B), and justify the ideas (C). Detail result of the mathematical communication skills of students in each indicators is shown in Table 20.

From Table 19, the minimum number of students who are in either category on a trial class is 26 students thus achieved percentage of 86.67%. While in the control class, number of students who are in good and excellent categories is 22 students so the percentage reached 75.86. Meaning that can be brought from posttest results are on trial class, teaching materials with RME effective in terms of mathematical communication skills. This is because the percentage of the minimum number of students who are in the category of either of these two classes each of more than 75%.

In Table 20 it is known that many students are minimal in a good categories for each indicator on the trial class (VIIA) has reached more than 75%, while the control class (VIIB) number of students in both categories indicator B has reached 75 %, however, to indicator A and B has lower than 75%. This means that the class VIIB, to express ideas visually and indicator interpret a visual representationstill unresolved.

Based on the explanations which have been mentioned above, it is known that good teaching materials with realistic mathematics approach and books BSE government owned equally effective in terms of mathematical reasoning and communication. Therefore, the analysis test is required to determine the effectiveness of the difference between the trial classes and control classes in terms of mathematical reasoning and communication simultaneously.

The hypothesis to be tested are as follows.
H_0= There is no difference in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical communication and reasoning skills students
H_1 = There are differences in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical communication and reasoning skills students

$H_0 : \begin{pmatrix}\mu_{11}\\ \mu_{12}\end{pmatrix} = \begin{pmatrix}\mu_{21}\\ \mu_{22}\end{pmatrix}$

$H_1 : \begin{pmatrix}\mu_{11}\\ \mu_{12}\end{pmatrix} \neq \begin{pmatrix}\mu_{21}\\ \mu_{22}\end{pmatrix}$

μ_{11}:average of mathematical reasoning skill at trial class

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μ_{12}: average of mathematical communicaction skill at trial class
μ_{21}: average of mathematical reasoning skill at control class
μ_{22}: average of mathematical communication skill at control class

Table 21. Multivariate Result in Terms of Mathematical Reasoning and Communication

Effect		F	Sig.
Kelas	Hotteling's Trace	3,198[b]	0,048

According to Table 21, the significant value by using Hotteling's Trace is 0.048 <0.05. These results lead H_0 rejected and H_1 accepted, that there is a difference effectiveness between classroom learning in terms of mathematical reasoning and communication. Because the test analysis it is known that there are differences in the effectiveness of learning between trial class and control class in terms of reasoning and mathematical communication simultaneously, then the next step is to determine which classes more effective by analyzing data posttest each variable in the using F-test with decision criteria H_0 rejected if the significance value <0.05.

Then, it would be analyzed each variable with F-Test. The first variable that would be analyzed was mathematical reasoning skill that shown in Table 22. The hypothesis to be tested are as follows.

H_0= There is no difference in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical reasoning skills students

H_1= There are differences in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical reasoning skills students

H_0: $\mu_{11} = \mu_{21}$
H_1: $\mu_{11} = \mu_{21}$

μ_{11}= average of mathematical reasoning abilities of students in the experimental class
μ_{21}= average of mathematical reasoning abilities of students in the control class

Table 22. F-Test Result for Mathematical Reasoning Skill

Posttest	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	76,995	1	76,995	8,052	0,006
Within Groups	545,039	57	9,562		
Total	622,034	58			

According to Table 22, the value of the data posttest significance F-Test using SPSS 16 software is 0.006 < 0.05. This means that H_0 rejected and H_1 accepted which means that there are differences in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical reasoning skills students. Because of average in the trial class is higher than control class, we can conclude that mathematic learning in trial class is more effective than control class. It means that learning using teaching materials with realistic mathematics approach is more effective than learning to use the book BSE in terms of students' mathematical reasoning skills.

The next variable that would be analyzed was mathematical communication skill. The analysis result has been presented in Table 23. The hypothesis to be tested are as follows.

H_0 = There is no difference in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical communication skills students

H_1 = There are differences in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical communication skills students

H_0: $\mu_{11} = \mu_{21}$
H_1: $\mu_{11} = \mu_{21}$

Table 23. F-Test Result for Mathematical Communication Skill

Reasoning Posttest	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	60,690	1	60,690	7,335	0,009
Within Groups	471,615	57	8,274		
Total	532,305	58			

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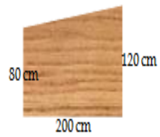
Table 24. Revised Product

No.	Revised	Before	After
1.	RME Context	Contextual problem still low	Completed with the problem that gave in “aktivitas mandiri” and “ruang diskusi”
2.	Definition	wrong definition	Definition has been appropiated
3.	Summary	Inconsistency in the summary	Writing summary is adapted to be consistent
4.	The use of a picture that less fit	Count area from the map that form trapezoid 	Count area from the plywood that form trapezoid 
5.	Literature	none	equipped
6.	Font	Too little (used font Garamond 11pt)	Modify to font book Antiqua 11pt
7.	Description of the image	A lot af picture isn’t included source	equipped
8.	Inconsistency	L = p × l = 6 cm × 4 cm = 24 cm2	L = p × l = 6 × 4 = 24 Luas persegi panjang = 24 cm2

According to Table 23, the value of the data posttest significance F-Test using SPSS 16 software is 0.009 < 0.05. This means that H_0 rejected and H_1 accepted which means that there are differences in the effectiveness of learning using teaching materials with realistic mathematical approaches and learning using books BSE in terms of mathematical communication skills students. Because of average in the trial class is higher than control class, we can conclude that mathematic learning in trial class is more effective than control class. It means that learning using teaching materials with realistic mathematics approach is more effective than learning to use the book BSE in terms of students' mathematical communication skills.

Based on the above analysis test, it can be concluded that the trial learning in the classroom (learning using teaching materials with realistic mathematics approach) is more effective to improve the ability of mathematical reasoning and communication skills of students rather than learning by using books BSE from the government.

In the validation process of teaching materials and learning reflection, the validators and the teachers gave various suggestions and input on product improvements. Some corrections and improvements to the text books of the validators and the teachers are shown in Table 24.

CONCLUSIONS

Based on the results of research and discussion concluded that mathematics teaching materials with realistic mathematics approach oriented communication and mathematical reasoning abilities of students who have developed is valid, practical, and effective in terms of mathematical reasoning and communication skills. A minimum percentage of the number of students who are in the good category reached 83.33% for reasoning and reached 86.67% for mathematical communication skills. These percentages indicate that learning using teaching materials with realistic mathematics approach effective in terms of reasoning and communication student for a minimal percentage of students who are in the good category is 75%. It is also reinforced by analysis test, that learning to teaching materials with realistic mathematics approach is more effective than learning to use the book BSE in terms of the ability of students' mathematical reasoning and communication.

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