

# DEVELOPMENT OF MATHEMATIC TEACHING MATERIALS BASED ON REALISTIC MATHEMATICS EDUCATION AT SDN IN BATANGHARI DISTRICT

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## Abstract

The purpose of this research is to develop mathematics teaching materials based on Realistic Mathematic Education (RME). The research method used is the Development Research method with a model from Dick and Carey which includes ten stages: Analysis of learning needs and objectives, analyzing learning, analyzing learners and the environment, formulating performance goals, developing instruments or test instruments, developing learning strategies, developing and selecting learning materials, designing and implementing formative evaluations, revising learning and designing and implementing summative evaluations. This research was conducted at SDN in Batanghari District. The results showed an increase in student learning outcomes using this RME-based mathematics teaching material. This can be seen in the pretest average score of 50.56 and the posttest average score of 83.60 where there is an increase of 33.05. The successful use of RME-based mathematics teaching materials is also supported by the active participation of students, teacher creativity, and linking daily activities so that it can be used as a medium for learning mathematics, especially the subject matter of the KPK and FPB.

**Keywords:** Mathematics Teaching Materials, Development Research, RME

## INTRODUCTION

The low mathematic score of stut was caused by most of them regard that mathematic subject was difficult and less intrested. Because of this assumption, student goal in knowledge learningis very determined by lesson strategy did by teacher as facilitator. Lesson did by two actors, are teacher and students. Teacher`duty did not only teaching (teacher centered), but more students learning (student centered). Students should be given opportunity be actively sense developing in learning activity, mentally, phisically, and socially.

Nowadays, difficulties in mathematic learning being increased along with advance enhancement in every aspect, include mathematic advance itself. Therefore, mathematic lesson is different with mathematic lesson previous developed. Depend on National Research Council (2001) All young Americans must learn to think mathematically, and they must think mathematically to learn. This term contains definition that American young generation who learnt mathematic had ability of reasoning, logic, and systematic thinking. It also be valid for Indonesian students who learnt mathematic.

Depend on sembiring, dkk (2014) in the world, RME also being take effect. For example, text book series based on RME "Mathematic in Context" Education Research Centered Wisconsin & Freudenthal Institute (2006) had quite large market share in USA. Second

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example was Indonesian Realistic Mathematics Education” based on RME in Indonesia. Based on research concluded that Realistic Mathematics Education (RME) as lesson approach that took effect yang berpengaruh to mathematic lesson, researcher would applied it into teaching materials based on RME.

Other research also did by Wahyudi, dkk (2017) with the title The Development of Realistic Mathematics Education (RME) for Primary Schools’ Propestive Teachers. In this research would developed RME Approach in elementary school lesson based on teacher perspective. Similar topic research also did by Heuvel and Panhuizen (2003) with the title The didactical use of models in realistic mathematics education: an example from a longitudinal trajectory on percentage. This research did by purpose to know about RME model application in longitudinal lesson that very effected in lesson development. Other research did by Trisnawati, dkk (2018) with the title The Effect of Realistic Mathematics Education on Student’s Mathematical Communication Ability. This research result that mathematic communicaton ability students increase used RME approach. Other research also did by Ardiyani, dkk (2018) with the title Realistic Mathematics Education in Cooperative Learning Viewed From Learning Activity. This research compared cooperative model and RME model, cooperative model used was STAD and TPS type from both model known that STAD lesson model better than TPS lesson model.

Other research also did by Revina, dkk (2018) with title Educational Borrowing and Mathematics Curriculum: Realistic Mathematics Education in the Dutch and Indonesian Primary Curriculum. This research explained about kurikulum RME for Elementary school students used in Indonesian but did not especially discussed, either generally discussed. With the contrary, in Netherland, RME has been especially discussed into curriculum. Other research also did by Fredriksen (2020) with title Exploring Realistic Mathematics Education in a Flipped Classroom Context at the Tertiary Level. This Researcher discussed about RME approach application for Flipped Classroom which the result was heuristic of RME that very helpful students in outside of classroom and made lesson video making inside classroom easier.

From those existed researchs conclude that Realistic Mathematics Education very helpful to students in mathematic lesson, where students would be more understand about mathematic because they directly meet to mathematic lesson context in the real life.. This

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research also would developed mathematic lesson based on RME. But this research would developed material teaching and analyze effectiveness material teaching level developed in mathematic lesson in grade 4 Elementary School. The novelty would be featured by researcher was material teaching based on RME infrequently used in Elementary school especially in research location.

Based on explanation above, researcher try developed mathematic teaching materials based on Realistic Mathematic Education (RME) to elementary school students. Application of mathematic teaching materials based on RME expected to create autonomous, active, creative and fun lesson to make students easier in comprehend lesson materials and upgrade learning motivation.

## **METHODS**

Depend on Borg and Gall (2007) explained about research and development in following citation:“ Research and Development in an development in industry-based development model in which the findings or research are used to design new products and procedures, which then are system actuallyfield-tested, evaluated, and refined until they meet specified criteria of effectiveness, quality, or similar standards.”

On citations above explained that research development did in industry world researched about product or procedure tested, evaluated and modified until the spesific, effective, high quality, and standard criteria found. This method can be applied in education world with similar procedure to lesson application. Modification did related to contain of a lesson product or procedure. Purpose of this research development was found most effective way of lesson, its process required teacher participation to perform various learning method experiment to get proper method for every certain classroom.

Depend on Gay (2009) research and development explained to following citation “Research and Development (R&D) is the process of researching consumer needs and then developing products to fulfill those needs. The purpose of R&D efforrts in education is not to formulate or test theory but develop effective products for use in schools. Such products include teacher-training material, learning materials, sets of behavioral objectives, media materials, and managemen system”

Citation above explained that research and development was process of finding out customers needs and developed proper product with customers needs. Purpose research and

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development was not to formulated test theory neither effective product for school, like development teacher, learning materials, lesson media, and management system. Previous explanation seemed that for this step focused on students needs, teacher should know more about students who be taught to know the learning needs. It did for formulate desired attitude change, material teaching be taught, applied media, and school management to find fun and proper lesson.

Generally, depend on Gustafson and Branch (2002) lesson development model was divided into three characteristic, they were: classroom orientation, product orientation, and system orientation. Classroom orientation was model that stress to a lesson activity in classroom. This model be guide for teacher to supervised, created lesson interaction, and motivated students with properway.

To date, this model still be applied by mot teachers in education institution. Disadvantage of this model was it unfocused to certain subject, and only few of lesson design component inside. Besides, this model stress to materials presentation, and class management by teacher, it caused undetected of other aspect effected lesson. Prawiradilaga (2007).

One example of lesson development model oriented class was model introduced by Heinich (2002) called by ASSURE.

The Step includes Analyze learners, State objective, Select methods, media, and material strategy, Utilize technology, media and materials, Require learner participation, Evaluate and revise.

while lesson development model oriented product was model developed to produce a teaching material product. The advantage of this model, whole activity of lesson can be measured and easy followed because focused on teaching material product. But this model also has disadvantages, no direct explanation about lesson activity and following lesson.

The other example of development oriented product model was model developed by Alessi and Trollip. Depend on Alessi and Trollip (1985) there were eight step of developing lesson based on Computer-based instruction, they were: (1) Defined your purpose, (2) Collected resource materials), (3) Generated Ideas for the lesson, (4) Organize your idea for the lesson, (5) Produce lesson displays on paper, (6) Flowchart the lesson, (7) Program the lesson, (8) Evaluate the quality and effectiveness of the lesson.

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Depend on Wubbels, dkk.(1997) brought out about Realistic Mathematics Education approach in following Journal of Educational Studies in Mathematicsas:“Themain difference with the mechanistic and structuralistic approaches is that realistic mathematics education does not start from abstract principles or rules with the aim to learn to apply these in concrete situations, nor does it focus on an instrumental type of knowledge. The process of constructing knowledge and principles by the pupils themselves gets the main emphasis. As Freudenthal (1978) puts it, this reflects a shift from mathematics as a created subject (created by others, especially mathematicians) towards mathematics as a subject to be created. This implies a more dynamic view of mathematics: mathematical actions and the process of developing strategies gets much more attention in comparison with static clear-and-cut knowledge. Freudenthal (1991) emphasizes that this presents children with the opportunity to ‘reinvent’ mathematical ideas”.

Based on Wubbels, dkk (1997) explained “main Differentiation with mechanistic and structuralistic approach was that Realistic Mathematics Education (RME) did not begin from abstrak principals or rule with purpose learn to apply in concrete situation, also did not focused to kind of knowledge instrument. It was stress on process of knowledge construction and students itself principals. Freudenthal (1978) said that it as reflection of moving from mathematic as subject who created by other person, especially cians matemathical to mathematic as subject who will be created. It average that dynamic point of view of mathematic: mathematic actions and strategy development process got more attention than its clear static and knowledge friction. Freudenthal (1994) that presented children with opportunity to 'reinvent mathematic idea”. “A typical example of a realistic mathematics problem is keeping track of ongoing changes in the number of bus passengers (Gravemeijer, 1994). In the situation of passengers who enter and leave a bus, addition and subtraction emerge in a natural way. The narrative about what happens at every bus stop leads to the development of some sort of-representation of the changes in the number of passengers (the description in Figure 1)”.

Gravemeijer explained about realistical mathematic based on our daily experience like : “a typical example realistical mathematic problem was changing happened of bus passenger number (Gravemeijer, 1994). In situation come in and come out passenger, increase and decrease appear naturally. Narration about things happened in every halte bus direct to

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development as representation from passenger number change (for example description to Picture 1)”.

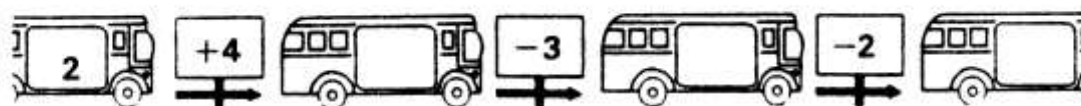


Figure 1. Chaining Bus

RME point view most determined by Freudenthal (1994), both of them were mathematics must be connected to reality and mathematics as human activity. Based on that point of view, RME had characteristics that lesson students should be given opportunity to reinvent mathematic through teacher guidance and that reinvention idea and mathematic concept tersebut should started from exploration various situation and real world problem.

Mathematic teaching materials Based on Realistic Mathematics Education (RME) developed with used Dick and Carey Method include two step described into following diagram:

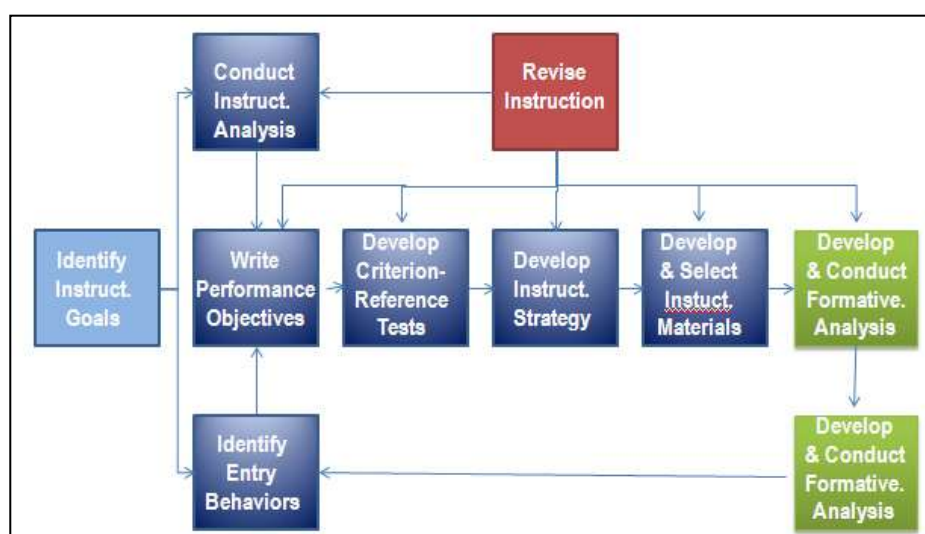


Figure 2. Model Dick and Carey

Location of this research was at state elementary school in batanghari district, Lampung Timur. It was did on 2020. This research used research and development method. Depend on Borg and Gall (1989), research and development method was "Process used to develop and validate educational products". It could be defined as a process used to develop and validated research products. Mulyatiningsih (2014) stated that research and development method purposed to produce new product through development process.

Research method used was model developed by Dick and Carey in Setyosari (2013) includes ten following steps were: (1) Analyzed needs and lesson purpose; (2) analyzed lesson; (3) analyzed lesson and environment; (4) decide purpose work show; (5) developed instrument; (6) developed lesson strategy; (7) developed and selected lesson material; (8) evaluated formative; (9) revised lesson; (10) design and summative evaluation.

This research used descriptive qualitative analyze technique. It was research technique that described research object based on visible facts or natural facts. Then, it used statistical descriptively, descriptive statistic technique was related methods with collecting and presenting a data cluster to give useful information yang berguna. While technique data collections used were: Questionnaire, Interview, and Test.

Before product development did, researcher observed some Elementary schools. In researcher view, lesson process did all this time, generally centered to teacher itself, teacher still more active in lesson activity as knowledge giver to students and be abstract. Besides also students regard that learn mathematic is very difficult and less interested. Model used in developing mathematic teaching materials used procedure and step of model stated by Dick and Carey. Explanation of procedure and step did this research were:

First, Researcher identified general purpose of lesson based on analyze needs. Second, Analyze Lesson. First step was classified lesson purpose should own was students ability to mention multiple and numeral factor, students ability to find multiple and common factor of two number and students ability to determined KPK and FPB. Third, analyzed students characteristics and environment. Characteristic of students grade 4 on concrete operational step on 10 until 11 years age. Fourth, formulated Indicators. Based on analyzed of intruclsional result, developed competency or specific purpose (intruclsional objectives) mastered by students to reach general lesson purpose (intruclsional goal).

**Table 1. Basic competency and Indicators**

Basic competency	Indicators
Restated with own sentence, stated own sentence, stated mathematic sentence, and problem solved with effective problems related to KPK and FPB terkait with daily activity at home, school, or playing ground, and check the validity.	<ol style="list-style-type: none"> <li>1. Determined multiple a numeral</li> <li>2. Determined multiple common of two numerals and multiple the least common (KPK)</li> <li>3. Determined factor a numeral</li> </ol>

	4. Determined common divisor and greatest common divisor (FPB)
	5.

Minimum completeness criterias was 65 set based on standard set by school and teacher deal.

Fifth, Mengembangkan Instrumen or Alat Tes. Sixth, Lesson strategy development. Lesson strategy used was development of mathematic teaching materials based on RME. Seventh, Developing and Selected Lesson material. For through this step researcher designed program lesson with applied lesson strategy in material teaching used. Material teaching developed based on RME.

Eighth, Designed and Developed Formative evaluation. Ninth, Revised the Lesson. After researcher did formative evaluation, nextstep was revised the draft mathematic teaching materials still in blueprint form to be mathematic teaching materials. Tenth, Designed and summative evaluation. Summative evaluation as assessment did to point of Dick and Carey model activity.

## RESULTS AND DISCUSSION

Mathematic teaching materials experiment did through four step includes: first step, expert judgement; second step, trial to some random students; third step, trial to small group; and four step, field experiment.

expert judgement did by two material teaching expert lecture and materials expert. Expert lecture about mathematic ini were Dr. Anton Noornia, M.Pd as materials expert, while Dr. Sigid Edy Purwanto, M.Pd as material teaching expert. Expert judgement ini was first evaluation step determined mathematic teaching materials properness of KPK and FPB topic. Both lectures gave score to mathematic teaching materials with valid category. Mathematic teaching materials topic KPK and FPB based on RME claimed valid and could be applied because they mutually sustainable between each component. Researcher continuous development of mathematic teaching materials ini with experiment to students.

One by One Test did by 5 students as respondent with proper characteristic and had different ability.



**Table 2. One by One Test**

No	Aspect	Average
1.	Likes	3,72
2.	Comprehension	3,68
3.	Book display	3,52
<b>Total score</b>		<b>3,64</b>

Based on tabel above result of test average 3,72. score described to “like” aspect which there were some children bored read books and prefer read story books than mathematic book. About aspect comprehension average also resulted score 3,68 dimana students after read books students easier to understand topic, after read books students able to fill questions given, and after read books students to be easier to comprehend discussed materials. But there were some student yang likesr comprehend questions given and could not fill questions given.

While to aspect book display average was 3,52. This indicated that book display attractive enough, students as children like ilustration picture inside book and they really like book display. But there were some students stated that book less attractive.

After revised of one by one test, followed by small group test include 10 students grade 4 Elementary school in batanghari district. Overall, students really this material teaching with score 3,83. The explanationnya presented in following table:

**Table 3. Test Small group**

No	Aspect	Average
1.	Likes	3,8
2.	Comprehension	3,84
3.	Book display	3,86
<b>Total score</b>		<b>3,83</b>

To “like” aspect had score 3,8 that described that some students disliked read books and liked to perpustakaan to found refference. Comprehension Aspect had score average 3,84 that described that students felt easy comprehend after read books, most of them students able to comprehend questions given and after read it students be easier to comprehend discussed topic. Only one student difficult comprehend questions given.

Book display aspect had average 3,86 it described that most of students stated that book display was very attractive, illustration picture was very attractive and students like book display. Only some students stated that book display less attractive.

Field experiment did to know effectiveness mathematic teaching materials developed. Effectiveness measured by pretest and posttest to know potential effect of students about mathematic teaching materials topic KPK and FPB based on RME and analyzed learning outcomes students before and after used material teaching with set minimum competency achievement score equal to 60 (sixty).

Pretest and posttest used in in lesson process with mathematic teaching materials topic KPK and FPB based on RME in multiple choices form as 15 questions and essay as 5 questions. Assessment used method: for multiple choice question score 1 of every questions while questions essay score 7 of every questions. Then both component added and multiplied to 2, then be converted to that score with interval 0-100.

Field experiment did to 40 students and through some steps. First step, students were given pretest before explanation about lesson used mathematic teaching materials topic KPK and FPB based on RME. In this step, students asked to answer some questions into questions page. Result of pretest indicated that topic KPK and FPB really need by students to increase comprehension and knowledge.

Based on this conclude that pretest score average 50,56 of 65,00 as maximum score. This score categorized as lower score and proven that students need assist in topic KPK and FPB lesson. After pretest, students given explanation to follow lesson with used mathematic teaching materials topic KPK and FPB based on RME. The materials presented in four times meeting about KPK and FPB.

Next step did by students was did posttest to assess mathematic teaching materials topic KPK and FPB based on RME. Posttest score average 83,60 with high category compared with KKM score should reached by students, it indicates that the whole as really good result.

To score pretest terdapat average score 50,55 kemudian after used mathematic teaching materials materi KPK and FPB average to be 83,60 increase as 33,05. Minimum pretest score 32,50 increased to 68 and maximum pretest score from 65 increased to 100. This indicated that significant increase of student ability in comprehend topic KPK and FPB.

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The trial of mathematics teaching materials is carried out in four stages which include: stage one, an expert judgment; stage two, randomized testing of several students; stage three, small group trials; and stage four, field testing. The expert feasibility trial was carried out by a lecturer who was an expert in the field of teaching materials and material experts, namely Prof. Dr. M. Syarif Sumantri, M.Pd. This expert test is the first stage of evaluation to determine the appropriateness of the mathematics teaching materials on the KPK and FPB subject. The two lecturers provided an assessment of mathematics teaching materials in a valid category. Thus the mathematics teaching materials on the subject matter of KPK and FPB based on RME are declared valid and can be used because they are mutually sustainable between one component and another. So that the researchers continued the development of this mathematics teaching material by testing it to students.

The trials were conducted into 3 categories, namely individual trials, small group trials, and field trials. Individual trials were conducted by five students to provide responses to the product design of mathematics teaching materials. The results of student comments will be used to revise the design of mathematics teaching materials that have been made. After the individual testing was complete, the researcher tested ten students called the small group. In this small group tryout, researchers will note how students carry out the learning process using mathematics teaching materials that are being developed. Furthermore, they gave responses to the first prototype generated through a questionnaire regarding student responses to mathematics teaching materials.

Based on the results of the students' responses of 91% for individual trials and 96% for small group trials with the category that this mathematics teaching material is practical to use. Practical mathematics teaching materials are mathematics teaching materials that can be used and utilized by students. This is done personally, using teaching materials needs to be done optimally, so that teachers can help students achieve competence, teachers are expected to be able to creatively create a combination of using learning methods and materials that can function in seeking successful learning.

Development of mathematic teaching materials topic KPK and FPB based on RME formulated systematically conform to level of comprehension students. This teaching material used concrete example until boosted students comprehend to middle concrete step and abstract knowledge about KPK and FPB through example related to reality.

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Field experiment did to know effectivity of mathematic teaching materials developed by. Result field experiment to real subject research, they were 40 students students grade 4, indicated that prototype third had potential effect to used to mathematic lesson. It seemed during lesson activity students really excited when did various steps of material teaching and no significant obstacles or called be effective. It strongly described that students really want fun and interesting way of learning to formulate easy understood presented concept.

Based on learning outcomes students in lesson activity after experimented used mathematic teaching materials developed by learning outcomes with average score 83,60 or >score 65 (score KKM). Mathematic teaching materials could be used by students. Thus product mathematic teaching materials developed had potential effect when it used in mathematic lesson activity in grade 4 SDN se-Kecamatan Batanghari. Researcher hope this mathematic teaching materials also useful for other Elementary school that want to use it in future.

This conclusion along with Sanjaya (2010) stated that material teaching increased and direct student attention be interested and motivated to follow lesson process.

## **CONCLUSION**

The former research did to get information about mathematic lesson activity on grade 4 students. Based on result of research did about development mathematic teaching materials topic KPK and FPB based on RME to students grade 4 in Elementary school conclude first, test mathematic teaching materials based on RME students grade 4 Elementary school stated as valid by materials expert and teaching materials expert until it called proper used in mathematic lesson. After experimented to students as individual and small group stated as practical thing, it proper used in mathematic lesson. Second, mathematic teaching materials development based on RME prove increased learning outcomes students after field experiment did through pre-test and post-test with result of learning completeness 13% and 100% respectively. It indicated that mathematic teaching materials topic KPK and FPB based on RME had positive potential effect to learning outcomes.

Based on conclusion result research did, mathematic teaching materials was developed with some development step got good response from students and teacher sehingga dapat dituangkan in 2 poin first, If mathematic teaching materials based on RME students grade 4 Elementary school stated valid by materials expert and materials expertal teaching, maka

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material teaching ini proper used in mathematic lesson individually and small group. Second, If mathematic teaching materials based on RME prove increased learning outcomes students after field experiment through pre-test and post-test with result of learning completeness 13% and 100% respectively. It indicated that mathematic teaching materials topic KPK and FPB based on RME had positive potential effect to learning outcomes.

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