Model of Geometry Realistic Learning Development with Interactive Multimedia Assistance in Elementary School

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Abstract. Initial research results indicate there are problems in learning mathematics, especially in geometry material in elementary schools. Students still have not had the opportunity to build their own knowledge. The purpose of this study is to produce a realistic learning model of interactive multimedia-assisted geometry to improve the reasoning ability of fourth grade elementary school students who meet valid, practical and effective criteria. This research is a design research that combines the Plomp and Gravemeijer & Cobb development model which consists of three phases: preliminary research (experimental preparation), prototyping phase (conducting experiments, retrospective analysis) and assessment phase. The subjects of the study were students of grade four SD thirty seven Pekanbaru. The results of the study indicate that the learning design developed has fulfilled valid, practical and effective. Valid in terms of content and construction. Practical in terms of implementation, convenience and time required. Effective in terms of potential impact on reasoning ability.

Keywords: Geometry Realistic Learning, Interactive Multimedia

1. Introduction
Geometry is included in one of three scopes of mathematical material ans id taught since grade one of elementary school. This is stated in Permendikbud No. 21 of 2016 concerning the standard content of mathematics subjects consisting of three main scopes, namely natural numbers and simple fractions, simple geometry and measurements, and simple statistic. Geometry can be seen as a mathematical system that presents abstract phenomena, but in learning it can be done in stages in accordance with the stages of child development. Geometry is a branch of mathematics in which visualization is one of the most important elements for understanding presented definitions and theorems, as well as for solving given tasks and problems [10]. Kennedy & Tipps (1994) [9] state that with learning geometry it is able to develop problem solving skills and support many other topics in mathematics.

Based on the results of interviews with elementary school teachers about learning geometry so far. The teacher states that learning in class takes place with a flow of explaining concepts / procedures, giving examples of questions and giving exercises, then students do the exercises in accordance with these examples. The teacher uses the textbook provided in the library without designing for himself how geometry material should be taught. The low mathematical beliefs of students can result in students participating less in the learning process, the lack of understanding structures and mathematical skills for everyday contexts [1]. The mathematical beliefs of a student are influenced by teacher factors, textbooks, learning strategies, and the main use of the problems that are around students in learning
activities [2]. Based on the analysis of textbooks in school, especially in learning geometry in elementary schools, for example in teaching material about flat arising, students are limited to seeing abstract images and memorizing the properties of flat arising, and memorizing building formulas flat served. Of course, learning like this is too abstract and not in accordance with students' thinking abilities. There are many ways to realize the goals of mathematics learning, namely managing contextual or realistic mathematics learning activities. Hadi (2005) [6] suggested that one of the efforts to reform mathematics education in Indonesia was through the development and implementation of Realistic Mathematics Education (PMR). Realistic mathematics education was first introduced and developed in the Netherlands in 1970 by the Freudenthal Institute. This realistic mathematics education refers to the opinion of Freudenthal who said that mathematics must be linked to reality and mathematics is a human activity. This means that mathematics must be close to the child and relevant to real life. Mathematics as a human activity means humans must be given the opportunity to rediscover mathematical ideas and concepts with adult guidance [5].

Realistic mathematics education is an approach in learning mathematics which is based on the view that mathematics as a human activity (Gravemeijer, 1994) [5]. According to [4] mathematics as human activity. Human activity in question includes looking for problems, organizing relevant material, making mathematical models, solving problems, organizing new ideas and new understanding that is appropriate to the context. This perspective involves mathematics not only as a subject, but as a human activity. To emphasize that the process is more important than the results, the term mathematical approach is used in the realistic mathematics, which is the process of mathematicizing the real world [15]. The word 'real' in 'realistic' means real in meaningful meaning for students. In RME / PMRI theory the lesson begins with real contextual material in terms of student experience (Gravemeijer, 2011) [5]. Hans Freudenthal's view that "mathematics as human activity" so that learning mathematics is considered the best is to do reinvention through daily problems (daily life problems) and then gradually develop into formal mathematical understanding.

Learning with a realistic approach makes students able to cast concrete conditions that exist in the real world into mathematical concepts. There is no exception to the concept material of the area of rectangles and triangles, by showing concrete objects and demonstration students are able to understand, abstract and formulate into their minds. In turn, students are able to apply geometric formulas that they have understood into problems that are real-world problems.

Research on realistic mathematics has been carried out by previous researchers whose results are quite encouraging. The results of previous studies concluded that students' mathematical abilities are better after being taught with a realistic mathematical approach (Fauzan, 2002; Armanto, 2002; Musdi, 2012; Kwont, et al, 2013; Stephan & Cobb, 2013; Rangkuti, 2015; Samin, 2016) [3]. Based on these results it can be concluded that realistic mathematics learning is very appropriate to improve students' mathematical abilities. Research in several countries shows that learning mathematics with a realistic approach can make mathematics more interesting, relevant, and meaningful. However, in realistic mathematics learning students sometimes need a long time to be able to find concepts until finally they can solve mathematical problems (Nopiyan D, 2016; Lestari & Surya, 2017) [16] . As the development of science in this globalization era, technology has become one of the media to be able to transfer knowledge. By utilizing technology, according to Centron (1988), the learning process to master science and technology is faster and saves time and the process will be more individual according to the needs of each student, but at the same time mass. Computers have a lot of software that can be used to help the learning process, especially mathematics. Some educational researchers state that computers are very potential to improve the quality of learning. (Sugeng, 1998; Liao, 1992; Jensen & Williams, 1993; in Herman 2003) [7]. One software that supports mathematics learning is interactive multimedia.

Interactive multimedia is a multimedia display that is designed so that the appearance fulfills the function of informing messages and having interactivity with its users [11]. Costantinescu (2007) [2] said that multimedia refers to computer-based systems that use various types of content such as text, audio, video, graphics, animation, and interactivity. Furthermore Purwanto (2004: 6) [17]. suggested
using interactive multi-media applications in learning, because interactive multimedia can optimize the role of the senses in receiving information into the memory system, so that it can be relatively more effective in building students' understanding structures. Interactive multimedia in question is a concept in the field of computer technology where components such as text, images, animations and videos are combined into one to be presented interactively.

The realistic learning model of interactive multimedia-assisted geometry is considered to be able to improve students' mathematical reasoning abilities. Because all this time the geometry learning process in elementary schools has not yet led to abstract nature and only uses the media that is around sometimes only to see pictures in student textbooks, and learning has not yet led to providing concrete examples of reinforcement. The realistic learning model of geometry assisted by interactive multimedia is expected to help elementary students in understanding geometry material.

2. Research Methods

This type of research is development research by combining the Plomp model and the Gravemeijer & Cobb model. To develop the learning model used Gravemeijer and Cobb models. The Gravemeijer and Cobb model consists of three phases, namely preparing for the experience, conducting the experiment and retrospective analysis [18]. To develop products from learning designs using the Plomp model. The Plomp model consists of 3 phases, namely the preliminary research phase, the prototyping stage and the assessment stage [5]. The preliminary research phase (preliminary research) consists of needs analysis, curriculum analysis, student analysis, concept analysis and literature review. Based on the results of the analysis in the preliminary research phase, a realistic geometry learning model is designed, for its operations students' books and teacher's books are designed.

In the prototyping stage phase, the prototype that has been made is assessed through formative evaluation. The design of realistic geometry learning models that have been designed are self-evaluated and validated by experts (expert review). The equipment validation was carried out by 3 Mathematics lecturers, one Education Technology lecturer and one Indonesian Language lecturer. After the design of a valid geometric realistic learning model is produced, one-to-one evaluations are carried out, small group evaluations / cycle 1 conducting the experiment is continued with retrospective analysis and field tests (field tests) / cycle 2 conducting the experiment to see practicality. In the assessment phase (assessment stage), an assessment of reasoning ability tests is conducted at grade IV SD 37 Pekanbaru students to see the effectiveness. Research data were collected through validation sheets, teacher and student response questionnaire sheets, observation sheets for the implementation of learning designs, interview sheets, and tests of students' mathematical reasoning abilities.

3. Result and Discussion

The study begins with a preliminary analysis. At this stage needs analysis, curriculum analysis, concept analysis, student characteristics analysis and literature review. Based on the needs analysis, curriculum analysis, analysis of students' concept analysis and literature review, a realistic learning model of class IV elementary school geometry was designed.

3.1 Prototype Design

3.1.1 Design of Realistic Geometry Learning Models

At this stage the learning model is designed, this model is designed using the elements that Joyce and Weil (2011) [8] consist of (a) the sequence of learning steps (syntax), (b) the existence of instructional principles, (c) social systems, and (5) support systems, (6) have instructional and accompanying impacts as a result of applied learning models Learning objectives here are intended targets or achievements that must be understood by students after they complete a topic or concept of geometry. Learning objectives are set at the beginning and then followed by a series of activities and prediction of students' answers and anticipation of answers by the teacher by giving inducement questions to achieve the learning objectives that have been set. The inducement question is given to stimulate students' thinking skills so that the learning objectives set can be achieved. Student activities and prediction of student answers are designed starting from simple and then continued with more
The task is expected to be able to develop the ability of horizontal mathematical towards vertical mathematical. In general, the realistic learning model of interactive multimedia-assisted geometry can be described as follows.

### 3.1.2 Teacher Book Design, Student Books and Interactive Multimedia

The teacher book designed in the Geometry Realistic learning model, has several components. This teacher book component, designed to adopt the Mathematics In context (MIC) teacher book in the Graping Equation chapter (see National Science Foundation, 1998) and combined with the writing of the National Education Book. Components of the teacher's books are learning objectives, time allocation, about mathematics, summaries, student ability assessment plans, student book pages and comments about problems. Whereas student books have components of learning objectives, student activities, contextual issues and understanding tests. Interactive media is designed as the main menu consisting of instructions, material, quizzes, geometry figures.

### 3.2 Formative Evaluation

Formative evaluations are carried out to assess the quality of the product designs developed. To assess the quality of the results of the design of model books, teacher books, student books and interactive multimedia using formative evaluation developed by Tessmer (2013) consisting of expert validation, one-to-one student interviews, small groups or simple evaluations (small group or micro evaluation), and field tests [11]. In the evaluation phase itself, mistakes occur in typos, unclear sentences and punctuation errors. For example in the model book, a repetition error occurs in the word "student can", written in the book the word "student can get". Error in punctuation for example, after punctuation is not given a space of 1 space. In the Teacher's Book the color of the shape used causes the writing to be unclear, and has also been corrected. After self-evaluation of the learning design of RME-based statistics topics that have been designed, further improvements are made.

### 3.2.1 Learning Design Validation Results

After self-evaluation, the learning design was validated by 5 validators, namely 3 mathematics lecturers, 1 education technology lecturer and 1 Indonesian language lecturer. In the model book aspects that are observed are aspects of supporting theories, model components, model implementation, linguistic, graphic.

| No | Aspek yang Dinilai                  | Rata-rata Nilai Validitas | Kategori          |
|----|------------------------------------|---------------------------|-------------------|
| 1  | Teori pendukung                    | 4,2                       | Sangat valid      |
| 2  | Komponen Model                     | 4,32                      | Sangat valid      |
| 3  | Pelaksanaan Model                  | 4,16                      | Sangat valid      |
| 4  | Kebahasaan                         | 4,1                       | Sangat valid      |
| 5  | Kegrafisan                         | 4,58                      | Sangat valid      |
|    | Nilai Validasi Buku Guru Secara Keseluruhan | 4,29                  | Sangat valid      |
During the validation process there are a number of revisions suggested by the validator. The validity value of the overall model book is 4.29 with a very valid category. Thus, it can be concluded that the aspect of the book component of the learning model of realistic geometry assisted by interactive multimedia is valid. Product implementations (teacher books and student books), were also validated. The results of teacher's book validation are stated in the following table.

**Table 2. Teacher book Validation Results Table**

| No | Aspek yang Dinilai | Rata-rata Nilai Validitas | Kategori       |
|----|-------------------|--------------------------|----------------|
| 1  | Perumusan         | 4.3                      | Sangat valid   |
| 2  | Tujuan            | 4.3                      | Sangat valid   |
| 3  | Sintak            | 4.3                      | Sangat valid   |
| 4  | Materi            | 4.3                      | Sangat valid   |
| 5  | Kebahasaan        | 4.3                      | Sangat valid   |
| 6  | Kegrafisan        | 4.3                      | Sangat valid   |
| 7  | Manfaat           | 4.3                      | Sangat valid   |
|    | Nilai Validasi Buku Guru Secara Keseluruhan | 4.36 | Sangat valid |

In the teacher's book the observed aspects are the dictatic or presentation aspects, material and content aspects, linguistic aspects, and graphic or display aspects. The overall validity value of teacher's books is 4.36 with a very valid category. Thus it can be concluded that the Teacher's Book with realistic multimedia assisted interactive geometry learning models that are designed is valid.

**Table 3. Student Book Validation Results**

| No | Aspek yang Dinilai | Rata-rata Nilai Validitas | Kategori       |
|----|-------------------|--------------------------|----------------|
| 1  | Kelayakan isi     | 4.05                     | Sangat valid   |
| 2  | kebahasaan        | 4.09                     | Sangat valid   |
| 3  | penyelisiran       | 4.55                     | Sangat valid   |
| 4  | kegrafisan        | 4.72                     | Sangat valid   |
|    | Nilai Validasi Buku Siswa Secara Keseluruhan | 4.17 | Sangat valid |

In the student book the observed aspects are the aspects of the content, grammar, presentation and graphic aspects or appearance. During the validation process there are several revisions suggested by the validators. The overall validity value of the Teacher's Book is 4.17 with a very valid category. Thus, it can be concluded that students with realistic multimedia assisted interactive geometry learning models that are designed are valid.

### 3.2.2 Results of Practicality of Learning Design

After all the products being developed are valid, then one-to-one evaluations are conducted with three students in grade IV SD 37 Pekanbaru with low, medium and high abilities. The first meeting is an individual evaluation with 2 hours of informal learning, then an informal interview is conducted. Then the book is given to students to be completed by the student at home. After the next three days informal interviews were conducted to ask for their responses to the learning models in the book. Based on the results of interviews with students in the one-to-one evaluation stage, in general high, medium and low ability students can understand the contextual problems that are presented in contextual problems that serve as starting points in finding each concept.

After a revision of the results of individual evaluations, the evaluation of this small group is also called the first cycle of conducting experiments on the development of the Gravemeijer & Cobb model. This small group evaluation was conducted on 6 grade IV students of Al Afattah Elementary School with high, medium and low ability. Small groups are carried out alternately with field tests, namely the first small group in class IV 5 Saturday and continued the first field test in class IX 6 on Wednesday, the second small group meeting on Wednesday continued with the second field test on Saturday, and so...
on. As a whole the design of learning geometry of this flat figure material can already be used in elementary schools.

Large group trials (field tests) are also called conducting second cycle conducting experiments. This learning begins with a realistic problem orientation 1, students understand and solve problems in horizontal mathematics, occasionally there are also students only discussing with their peers (in pairs). The teacher provides guidance and stimulus to students who need it, then the teacher chooses students to deliver their work to the class. Next students complete realistic problem 2 assisted by interactive multimedia. The following interactive multimedia display, in Figure 1.

![Figure 1](image1.png)

**Figure 2.** Cover Design Guidebook, Main Menu and Interactive Multimedia Material Contents

Based on the results of the questionnaire given to teachers and students. The following results are obtained.

| Table 4. The Results of Practically by the Teacher |
|-----------------------------------------------|
| No | Aspek yang dinilai | Berata Nilai Prakteklitas (%) | Kategori |
|----|-------------------|-------------------------------|----------|
| 1  | Petunjuk          | 90,4                          | Sangat Praktis |
| 2  | Materi            | 92,5                          | Sangat Praktis |
| 3  | Lembar Kerja      | 85,4                          | Sangat Praktis |
| 4  | Bahasa            | 89,4                          | Sangat Praktis |
| 5  | Bentuk Fisik      | 85,6                          | Sangat Praktis |
| 6  | Manfaat           | 86,7                          | Sangat Praktis |
| Nilai Praktekilitas | 88,33                  | Sangat Praktis |

The practicality value of the geometric relistic learning model design obtained from the teacher questionnaire was 87.5% with a very practical category based on practicality criteria. Thus it can be concluded that the teacher considers the design of RME-based statistical topics as practically used in Statistics IX class of SMP / MTs.

| Table 5. Results of Practically by Students |
|------------------------------------------|
| No | Aspek Penelitian | Skor | Kriteria |
|----|------------------|------|----------|
| 1  | Petunjuk         | 90,4 | Sangat Praktis |
| 2  | Materi           | 92,5 | Sangat Praktis |
| 3  | Lembar Kerja     | 85,4 | Sangat Praktis |
| 4  | Bahasa           | 89,4 | Sangat Praktis |
| 5  | Bentuk Fisik     | 85,6 | Sangat Praktis |
| 6  | Manfaat          | 86,7 | Sangat Praktis |
| Nilai Praktekilitas | 88,33 | Sangat Praktis |

The practicality value of the geometric learning model design obtained from the student questionnaire was 88.3% with a practical category based on practicality criteria. From the results of the questionnaire analysis filled out by students, the design of the geometric learning model is easy to use, interesting, can be well understood, can motivate students to learn mathematics and find concepts well. Thus it can be concluded that students consider the design of geometric realistc learning models assisted by this interactive multimedia practically used on the geometry topic of class IV flat geometry.
3.2.3 The Effectiveness of Learning Design

The design of interactive multimedia-assisted geometric realistic learning models is seen from the results of students' mathematical reasoning tests. This mathematical reasoning ability can be seen from the ability of students to give opinions with different answers or strategies. In the picture of learning implementation above, several examples of student reasoning have been described. Student learning starts from informal mathematics to formal mathematics. The process that occurs in finding the concept of a flat wake. With the learning model applied, students can discuss and exchange opinions. The variety of answers and opinions expressed by students shows that students' reasoning is increasing when compared to previous learning.

### Table 6. Reasoning Ability Test Result

| Indicator Penalaran                              | Persentase (%) | Keterangan |
|-------------------------------------------------|----------------|------------|
| Mengamati pola atau keteraturan untuk membentuk generalisasi |                 |            |
| Memeriksa penelitian mengenai fakta dan sifat-sifatnya. |                 |            |
| Memeriksa penelitian mengenai karakter konsit dan sifat-sifatnya. |                 |            |
| Mengkonstruksi atau menulis |                 |            |
| Menggambarkan konklusi logis tentang soal yang diajukan dan keterkaitannya |                 |            |

The success of achieving students 'mathematical reasoning ability is 75.5% with very successful criteria and the average test result of students' mathematical reasoning abilities is 67.4 with successful criteria. Thus it was concluded that the design of realistic geometry learning models assisted by interactive multimedia grade IV elementary school, this effectively had an impact on students' mathematical reasoning abilities. After the learning process ends, researchers, teachers, and observers discuss the extent of the implementation of the design of learning tools. The overall design of this interactive multimedia-assisted realistic geometry learning model has been used for learning geometry.

4. Conclusion

Based on the results of data analysis, it can be concluded that the learning design of realistic multimedia geometry-assisted interactive learning models that are designed has been valid, practical, and effectively used to improve the mathematical reasoning abilities of class students. Based on the conclusions above, the design of geometric learning models assisted by interactive multimedia can be used as a guide for teachers in implementing learning to improve students' mathematical reasoning abilities.

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