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Development of Realistic Mathematics Education (RME) Based Geometry Learning Design for 8th Grade Junior High School Students

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***Abstract*— This research is conducted to examine students' mathematical reasoning skills by using Realistic Mathematics Education (RME) based geometry learning design. It is started with daily-related problems to develop students' knowledge in solving mathematical problems. This learning design includes preliminary research phase, developmental phase, and retrospective analytical phase. This research is conducted on grade 8th students of MTsN 2 Agam, West Sumatera. The data is retrieved from observation, interviews, and questionnaires on students and teachers. The findings show that the usage of teachers book and students book are already valid and practical.**

***Keywords*— RME, Learning Trajectory, Design Research**

I. INTRODUCTION

Mathematics mastery is intertwined with the basic concept. It is based on Permendiknas No. 58 year 2014 which states that mathematics subject is aimed for students' understanding and competency in explaining relations between concepts and using the concepts and algorithm in an accurate, flexible and efficient way .[1]

Geometry is one of mathematical subject for grade 8th students. The lesson is focused on surface areas and volumes of cube, cuboid, prism, and tetrahedron. Geometry is one of essential lesson that is intertwined with other mathematical concepts. Furthermore, geometry also provides crucial context to develop reasoning and thoughts process in entire mathematics problem. It is based on Kennedy, Tipps, and Johnson theory (2008) saying that geometry is an extremely important subject to learn because it is intertwined with daily things such as buildings, fashion, culture, and animation.[2]

Based on the writer's observations and interviews with mathematics teachers of grade 8th MTsN 2 Agam, it is found that the conducted learning process has been mechanistic. It causes under-developed students' reasoning skill in solving mathematics problems that are related to daily activity. The lack of students' ability to understand mathematical problems affects students' achievement. Based on Rosita [3], students with high reasoning skills are able to understand and solve mathematics problem and vice versa. Accordingly, Rizta [4] reveals that students, who solve problems indirectly with their reasoning skills, also improve their thought process.

Supposedly, in geometric thinking students involve a cognitive process of visualization and reasoning [5].

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Geometric reasoning refers to the act of "creating and using a formal conceptual system to investigate form and space". [6] Therefore, in order to understand mathematics especially the topic of geometry well, students should use reasoning skills to facilitate students in understanding the material being taught.

Russell [7] argues that mathematical reasoning is the centre of learning mathematics. It shows that how important reasoning skills for students in order to learn and understand abstract mathematical concepts. The lesson prior is always related to the next lesson. In addition, reasoning is also needed by students to learn other subjects as well.

Fauzan [8] states that one of the goals of mathematics education in Indonesia elementary school is to prepare students to use mathematics and mathematical reasoning in their daily life and other subjects. Thus, mathematics is important for daily life and other lessons. Reasoning skills also allows students to understand volume measurement in geometry as it is stated by Battista & Clements [9] explaining that reasoning has a major role in developing cognitive ability to understand the measurement and the formula.

Based on the stated problem, one of the solutions is to develop a learning course design that is effective and accurate. The design has to facilitate students to build their own knowledge, grow their own curiosity, and think critically and creatively so they can solve the mathematics problem by using their own way. Therefore, the writer conducts this research to develop a learning course design to facilitate students to think critically, be active, and understand mathematics concepts in an effective way.

Learning course design that is developed in this research is a Realistic mathematics Education (RME) based mathematical learning. RME approach is an approach in which mathematics is regarded as human activities and learning mathematics is doing mathematics [8]. In this approach, students are allowed and pushed to propose their own ideas by using their own strategy to solve given mathematical problems.

Azhar & Kusuma [10] in their research find that learning with RME has succeeded to improve the learning result on several elementary and junior high schools in Indonesia. Fauzan and Yerizon also identify that students' reasoning skill that are taught with RME are better than those who are taught conventionally[8]. On top of that, it is triggered by horizontal process and vertical mathematics that are conducted in solving RME contextual problems. The horizontal process has been able to train students reasoning skill inductively because they are given chances to reasoning by using their own ideas. Consequently, the students receive more knowledge on how to measure geometry surface area and volume.

II. METHOD

This research is a developmental research. It is conducted by combining two kinds of design research: Plomp model [11] and Gravemeijer [12]. Plomp developmental model includes three phases: Preliminary investigation, prototype stage, and assessment phase.[11] Also, Gravemeijer and Cobb model consists of three phases: preparing for the experiment, conducting the experiment, and retrospective analysis [12].

This combination design research is conducted to achieve excellent learning product trajectory as one of the solution from education-related problem. The developed product is in the form of teacher book and students book that are RME-based on geometry lesson in 8th grade MTsN 2 Agam.

III. RESULT AND DISCUSSION

This research is started with preliminary research phase. In this phase, requirement analysis, curriculum analysis, concept analysis, characteristic analysis and literature review are conducted. Based on the analyses and the reviews, an RME-based geometry learning course is designed for 8th grade students.

1. Prototype design

a. Hypothetical Learning Trajectory (HLT)

In this phase, Hypothetical Learning Trajectory is designed by adopting Simon's HLT [13] which includes three parts: learning purpose, activity, students' answer prediction, teachers' anticipation, and students' answer with their thoughts process. The learning purpose involves the target or goal that is expected to be understood by students after they have finished one topic or one mathematical concept. The purpose is set at the beginning and followed by a series of activity and students answer prediction including anticipated answer from the teachers by asking them question to achieve the expected goal. Inducement question is also given to prompt students cognitive ability so the expected goal is achieved. Students activity and answer prediction are designed starting from simple problems to more complex ones. The activity is expected to develop horizontal mathematical ability toward vertical mathematics. The designed rational HLT is:

During the learning on geometry lesson of 8th grade students, it is designed with 2 HLT. The first HLT includes activity to measure surface area during wrapping gifts,

making tents, and wrapping kipang. The activity is chosen because in order to do all those activity above, the students have to understand the object that they are about to make. The designed lesson starts with measuring surface area of cube, cuboid, prism, and tetrahedron. The cube is chosen as the first object because the simplicity of the object in measuring its surface area.

The second HLT is designed to identify geometry volume concept through activity such as filling cubic and cuboid boxes with palm sugar that each comes with a cubic shape. Packing the boxes with cubicle palm sugar prompts students to acknowledge that measuring a cube or cuboid volume can be done by multiplying the base surface with the height of the box itself.

b. Teachers and students book

Teachers book that is designed in this RME-based learning consist of several components. They are designed by adopting Mathematics in Context (MIC) teachers book about Grasping equitation (National Science Foundation, and combined with the national book writing procedure[14]. The components are the lesson's goal, time allocation, mathematics, summary, students' ability assessment plan, students' book page, and comments on problems. Meanwhile, students book includes the lesson's goal, students activity, contextual questions and comprehension test.

2. Formative Evaluation

Formative evaluation is aimed to assess the quality of the designed products that are developed which is HLT, teachers book, and students book. The evaluation is conducted by using formative evaluation developed by Tessmer [15] that includes expert validation, face-to-face student interview, small or simple group evaluation, and field test.

Table 1. HLT Total Validation Result

No	Aspects	Average	Category
1	Content	3,37	Valid
2	Language	3,50	Extremely Valid
Total Average		3,43	Extremely Valid

Table 2. Teachers Book Total Validation Result

No	Aspects	Average	Category
1	Content	3,36	Valid
2	Language	3,25	Valid
3	Presentation	3,40	Valid
4	Language	3,80	Extremely Valid
Total Average		3,45	Valid

Table 3. Students Book Total Validation Result

No	Aspects	Average	Category
1	Content	3,50	Extremely Valid
2	Language	3,50	Extremely Valid
3	Presentation	3,40	Valid
4	Appearance	3,75	Extremely Valid
Total Average		3,53	Extremely Valid

After all products have been validated by experts and proved valid, students book is tested one to one on three students with different competence. Then, it is followed by small group testing in order to examine the practicality of the book. The result is shown at the table below.

Table 4. Students Questionnaire Analysis Result toward Small Group Testing

No	Aspects	Aspects Practicality Score (%)	Category
1	Manual Instruction	75,6	Practical
2	Time Efficiency	74,6	Somewhat Practical
3	Interest	82,1	Practical
4	Comprehensiveness	79	Practical

5	Students book benefit	70,3	Somewhat Practical
Total Average		76,32	Practical

Based on Table 4, it is found that RME-based student books for each aspect belongs to somewhat practical and practical categories and it is achieved that the practicality of the product is 76,32%. Based on the students interview, it is noted that the students are aided with the students book presentation that are related with things that are close with their daily life.

ACKNOWLEDGMENTS

Based on the conducted development result, it is found that Realistic Mathematics Education (RME) based geometry learning product for 8th grade students which involves teachers book and students book are valid and practical. As this research has been completed, the writer would like to suggest conducting another RME-based learning course toward other mathematical subject.

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