Preliminary Research of Mathematics Learning Device Development Based on Realistic Mathematics Education (RME)

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Abstract.-Based on the preliminary research stage conducted in Public Junior High School (SMPN) 3 Muara Bungo, it is obtained that students’ reasoning ability is low and has yet achieved optimum result. This is due to inappropriate learning device available in which it is yet facilitating the students in improving their mathematics reasoning. Therefore, it is of vital importance to develop learning devices in the form of lesson plan (RPP) and student worksheet (LKPD) based on Realistic Mathematics Education (RME). RME provides more opportunities for the students to be more active in comprehending mathematics concept, think logically, and are able to draw a problem fine conclusion. The purpose of this research is to obtain valid, practical, and effective learning device based on RME for class VII of Junior High School. Research data were collected through observation, interview, document, questionnaire, and mathematical reasoning ability. The research participants are students of class VII SMPN 3 Muaro Bungo. This is a model development research. Plomp model was employed as the development model in this research. There are 3 phases on this model, namely, preliminary research phase, development or prototyping phase, and assessment phase. However, this research focuses only on preliminary research phase. It is including things required to design the expected learning device. The result of preliminary research is 1) students’ mathematical reasoning ability has optimum yet; 2) class VII students are in their transition from elementary school to junior high school level; hence mathematics learning requires concrete learning object or mathematics learning should be linked with their daily life; 3) RPP used provides less support to improve students ability in mathematical reasoning and it provides less opportunities for the students to be more active; 4) students expected that LKPD has to be detail, attractive, fun, and easy to comprehend.

1. Introduction
Mathematical reasoning ability is one of the ability required in Mathematics Learning Curriculum for Junior High School. The regulation of national education ministry (Permendikbud) No. 58 stated that the purpose of mathematics is to get the students use their reasoning in mathematics activity [1]. In addition, National Council of Teachers of Mathematics NCTM (2000) stated that reasoning ability is one of the requirements on mathematics learning [2].

Mathematical reasoning ability is the ability to comprehend mathematics idea in a more detail way, to observe data, to explore information, to manage prediction, to have analogy, to generalize, and logical
thinking in hopes that the students would be able to solve mathematics problem in a structured, systematic way as well as can draw conclusion [3] [4] [5]. In the other words, it can be said that, mathematical reasoning ability is the students’ ability to comprehend mathematics through exploration on a variety of information related with the problem, create a logical prediction, and to draw a conclusion based on the proved right statement.

The importance of mathematics reasoning ability also revealed by Ayal et.al (2016) and Sumartini (2015), that is to enable the students to comprehend the concept, propose prediction to later arrange the evidence and manipulate mathematics problem as well as draw an appropriate conclusion in a right and exact ways[6] [7]. Reasoning ability is of vital importance for the junior high school and university students in comprehending learning material or mathematics concept [8].

The result of TIMSS in 2011 revealed that the percentage of reasoning is only 25%. The students’ low ability in reasoning also stated by Rosnawati (2013), Sulistiawati (2014) that students’ mathematical ability particularly mathematical reasoning ability is still low due to the students are involved in mathematics learning. Teacher tends to be active. It is also revealed that, students have a low interest in mathematics due to mathematics learning is less attractive [9] [10]. Next, Prasetyo et.al (2018) revealed that there are numbers of students who are unable to test the result in a calculation process, unable to proof mathematics expression, and unable to explain the rules used in solving mathematics problem [11].

The fact that shows students’ low ability in mathematical reasoning also found in the field. This is based on the interview result with some students and teacher in SMP Negeri 3 Muara Bungo who stated that student find it difficult to answer questions which require logical reasoning. It is hard for the students to well comprehend the question, to explore information contained in the question, less able to draw conclusion and to test the result obtained. Some students are struggling to imagine the problem by themselves and so they keep asking their peer and their teacher. However, some students can answer correctly but the answer is not arranged in a systematic way, as the effect they are not able to reveal the solution of the problem.

One of the causes to the low of students’ mathematical reasoning ability is that mathematics learning is still oriented on the mastery of basic skill and less involving in real life context as well as mathematical reasoning [12]. Next, Ramdani (2011) and Napitupulu et al (2016) stated that mathematical reasoning ability has optimum yet due to students understanding tend to be instrumental as for the learning tend to be traditional [13] [14]. Therefore, it is very important to plan on how to solve those above problems.

Learning process cannot be separated from the use of learning device; however learning device used is less supportive in improving students’ mathematical reasoning ability. This is supported by Suryawan (2017) and Sulistiawati and Hasratuddin (2017) who stated that learning device is less in facilitating mathematical reasoning, supposedly mathematics learning is a meaningful learning, so that students can develop their own ability and they no longer perceive that mathematics is an abstract [15] [16]. Next, Dewi and Harahap (2016) revealed that one of the causes to the low students’ ability in mathematical reasoning is that the learning device used is not effective yet in facilitating students’ mathematical reasoning ability [17].

Based on the result of lesson plan analysis used by teacher, it can be seen that learning activity designed by teacher are less supporting in facilitating the students to construct their own knowledge. The main activity shows that teacher tend to explain directly the formulation, provide very simple problem sample, and next ask the students to work on exercise. The problems available are limited to have students to use the formulation and to do calculation operation only. Students are not used to work on problem which involving reasoning and comprehending the presented material. Non routine problem is rarely exposed to the students; hence students tend to experience difficulty and confuse when working on a different and more varied kind of questions.
In the learning process, students are less active in solving problems as instructed by the teacher. This has caused the low achievement of their learning result. Students tend to find it difficult to answer the question and tend to wait for the answer from their high achievement peer. When no students are unable to provide answer, teacher finally writes the answer on the whiteboard. Teacher provides fewer stimulants for the students to allow them answering the question.

One of the learning resources is LKPD (student worksheet). Teacher use LKPD in order to get the students to read more and solve problems. The analysis result of LKPD used by teacher shows that the learning material is go directly to the core part or the formulation part. There are no found procedures or steps to encourage students to construct their own knowledge. Mostly, it is just summary of learning material along with competence test in the form of questions that have to be answered by the students.

LKPD used by teacher is not developed by the teacher himself/herself. As the consequence, not all contents in LKPD match to students’ characteristics. Therefore, teacher is required to be more active and creative in developing the teaching material.

Learning device development focuses on students’ mathematical reasoning ability. This ability is very important to be developed considering that reasoning ability will influence students learning result [18].

Based on the above explained problems, learning device which provides opportunities for the students to be actively engaged in facilitating themselves improving their mathematical reasoning ability is required. One of the learning approaches to solve the problem is learning with Realistic Mathematics Education (RME). It is expected that learning based on RME will be able to improve students’ mathematical reasoning ability.

RME learning is able to facilitate students in improving their mathematical reasoning ability in which later will influence the students’ achievement. This is in line with Sembiring (2010) who stated that RME learning is learning which is able to improve students’ mathematical achievement [19]. Through RME learning, students experiencing meaningful learning and is able to comprehend mathematics with reasoning [20].

RME learning contains things which support logical thinking in order to be able to conclude the problem. This is one of mathematical reasoning indicators. There are three key principles of realistic mathematics learning, namely, guided reinvention, didactical phenomenology and self developed models [21].

Moreover, according to Fauzan (2002) RME learning allows an interactive teaching and learning process, so that students can pay a great focus attention toward all activities in classroom [22]. Next, Habsah (2015) revealed that providing realistic problem through RME can be used to train students’ reasoning ability by relating real life problem with formal mathematics [12]. The connection between mathematics terms daily life expression will facilitate the students to relate formal terms and their previous informal knowledge. Based on the explanation above, RME learning facilitates students in improving their mathematical reasoning ability.

RME characteristics are to facilitate students’ mathematical reasoning ability. Treffers (1991) mentioned RME characteristics as follow, (1) containing contextual problem, by presenting daily life problem it is expected that the students will be encouraged to identify and comprehend process of mathematics problem solving, thus will improve the reasoning ability. (2) Developing model of the problem given where students look for predictions in order to be able to solve problem in a more systematic way based on mathematical reasoning indicator that is to solve problem systematically. (3) Employing the contribution will help the students to use the knowledge they possess in order to build new knowledge by expressing ideas in solving a problem. (4) Interactivity. (5) Containing connection for both among mathematics topics and among other learning subjects. It is expected that the implementation of RME learning device can facilitate students in building their reasoning ability [23].
LKPD that will be developed is the one with steps referring to learning based on RME which provides opportunities for the students to construct their own knowledge, able to solve problem logically, well understanding the question, able to explore information related with problem, making prediction, and making conclusion from the tested solution. It is expected that this learning process will train their reasoning ability to solve the problem given.

The developed lesson plan is the one which is in line with the learning concept based on RME and related with daily life. This lesson plan will serve as a guide for the teacher in implementing learning, so that this learning activity will be more systematic, make students more active, and so the learning process will be better.

2. Method
This is a Plomp development model research which consists of three phases, namely, preliminary research phase, development or prototype phase, and assessment phase.

Preliminary research phase consists of needs analysis, curriculum analysis, concept analysis, and student characteristics analysis. Needs analysis is to reveal mathematics learning condition at school or problems faced in mathematics learning by both teacher and students. The result of need analysis will be consideration in designing mathematics learning device. This activity conducted by observing classroom learning and interviewing teacher.

Curriculum analysis is to analyze curriculum employed at school particularly on mathematics learning for class VII of Junior High School. Next, concept analysis step aimed to determine the content and learning material that can be presented on learning device. The analysis result will be used for preparing aspects related with mathematics learning design and development.

Student character analysis is implemented to discover students’ characteristics, students’ difficulty in mathematics learning, students’ ability and comprehension, the form of the expected learning material, learning expected by the students, and LKPD expected by the students. Student need analysis is implemented by giving questionnaire and interview with teacher.

Development or prototype phase consists of prototype 1: self evaluation, prototype 2: expert assessment, prototype 3: face to face evaluation, prototype 4: small group evaluation. Device validation is conducted by 3 mathematics lecturer, 1 Indonesian language lecturer, and 1 education technology lecturer. On the assessment phase, field test is conducted in class VII of Public Junior High School (SMP N) 3 Muara Bungo in order to see the practicality and the effectiveness.

Data were collected through self evaluation sheet, validation sheet, observation and interview guidance sheets, teacher and student respond sheets, and mathematical reasoning ability test.

3. Result And Discussion

3.1. The result of needs analysis
This phase is to collect information to uncover the condition and problems encountered in mathematics learning process at school. This kind of information is obtained through observe directly on how teacher implement learning, teacher interview, and distribute questionnaire to students about things that has to be improved on mathematics learning device.

Based on the observation of classroom learning activity, it can be seen that the implementation of learning is well executed and in line with the lesson plan, however the lesson plan employed has optimum yet to improve students’ ability as well as to construct students’ knowledge. In the practice, it is obvious that teacher is more active comparing to the students. This is in line with the research result conducted by Nasution and Yerizon (2019) who revealed that based on their analysis teacher is still dominating in classroom learning in which supposedly students are required to be more active [24].
On the early stage of learning, teacher has delivered the use of learning material, so that students get more familiar to the learning material. In fact, in its practice, teacher directly exposes the students with the formulation without telling the students the process or the origin of that formulation. As the consequence, students tend to remember rather than deeply comprehend the formulation. The example given is the question related with real life situation, but mostly it is just to guide the students to do calculation only without knowing the meaning and the purpose of the problem solving. When exposed to a more variety questions, students start to develop inability to solve the problem.

In respond to all above conditions, interview with the teacher regarding problems encountered during learning process is then conducted. The result of the interview shows that students find it hard to comprehend real life problem and story type question, both given by teacher and questions in LKPD. Steps and problem found in LKPD provides less facilitation for the students to comprehend and solve real life problem, formulate the problem, and making inferences or prediction, and to finally determine the strategy they would like to use to solve the problem.

Based on the result of questionnaire distribution toward 30 students, it is found that most of the students use LKPD or student worksheet since it displays detail information on learning material. However, it is yet able to construct students’ knowledge and merely focuses on the use of the formulation. As the effect, students less develop their own knowledge, less active in solving problem. In fact, the students are expecting the LKPD to be attractive, easy to understand, enrich with pictures, and the problem given is closer to daily life situation.

Based on the previous observation, it can be said that RPP and LKPD are in need of improvement. Therefore, a solution toward the problem is of vital importance, a solution which enables the creation of learning device in order to improve students’ mathematics reasoning ability. Based on this analysis, it can be concluded that learning device based on RME is considered as suitable to answer the above problem.

The steps of RME learning based on its principle and characteristics are:
1. Comprehending contextual problem
2. Explaining contextual problem
3. Solving contextual problem
4. Comparing and discussing problem
5. Concluding

Finally, learning device based on RME is not only allowing the improvement of students’ mathematical reasoning ability, but also to enable students to engage actively in the learning process, to work together, and to provide opportunity to improve their mathematical reasoning ability.

3.2. The result of curriculum analysis
Curriculum analysis is to investigate the suitability of KL and KD with curriculum 2013, the suitability of competence achievement indicator with KD, and the suitability of learning purpose with competence achievement. Based on the curriculum analysis conducted by the researchers, it is found that KI and KD are in line with curriculum 2013. There is no changes found on the established KI and KD, however there is a change in the form of competence achievement indicator on learning material.

The changes took place on the competence achievement indicator is based on many consideration. First, the intended indicator is too complex and unspecified. Second, syllabus indicator is rearranged by separating indicator 3.5 and 4.5 aimed to focus the learning.
3.3. The result of concept analysis
Concept analysis is to reveal the subject required in developing learning device to fulfill the competence achievement indicator. The required subject in the learning will be arranged in the form of concept mapping. The result of concept analysis will be the basis for designing mathematics learning device based on RME in the form of lesson plan (RPP) and student worksheet (LKPD).
Concept analysis also including material analysis in order to identify sub materials that will be learned by the students on algebraic material adjusting the uniqueness of school condition, as follow:
1. Introduction to Algebraic
2. Algebraic operation including addition, subtraction, multiplication, and division on Algebraic form.
3. Simplifying fractions of Algebraic forms

3.4. The result of student analysis
Student analysis is to reveal students’ characteristics. Students’ characteristics are including difficulties encountered by the students during mathematics learning, students’ comprehension, students’ learning style, and students’ expectation on learning material. In order to discover these, researchers conducting interview, observation, and questionnaire distribution.

The first characteristic is students’ thinking level is still low. This can be seen in the way the students solve the problem given by teacher. There are only 1 or 2 students who are able to solve the problem given by teacher.
The second characteristic is that students are in concrete development stage to formal stage or start to enter the abstract world. It is due to the subjects of the research are class VII students aged ranging from 11 to 13 years old. They are still in the transition time from Elementary school to Junior high School level. It implies that they need concrete things on mathematics learning along with contextual or daily life problem. This is in line with the research result conducted by Roza et.al (2018) who revealed that problem context that will be exposed to students must be familiar to all students [25].
The third characteristic is students’ tendency in learning. Their participation tend to be less active since the learning resource is less attractive, less innovation of learning method employed by teacher, and the students’ interest. Based on the questionnaire distributed to students, it is found that students tend to study in group rather than work independently. They find that it is much easier to discuss the problem solving in group work. Hence, it is necessary to create learning to improve students’ participation and interest.
The fourth characteristic is students find it difficult to solve problem given by teacher. Students are able to work on the first sample question, but when it comes to a different kind of question, students are failing to work on it since they refer only to the first sample question. Unfortunately, the first sample question is only about the application of formulation usage which requires students to perform only multiplication operation. Therefore, it is of vital importance to allow learning process which enables the students to construct their own knowledge about the origin of the formulation. This is to improve students’ comprehension and reasoning, so that whenever they need to work on a different type of question, they will be able to perform excellent reasoning ability.
The fifth characteristic is most students are dissatisfied with LKPD given by teacher. They think that it is less attractive, black and white only, less pictures, and too many questions. This is supported by the analysis result of Yerizon et.al (2018) that LKPD used by students need to be in a great variety, brief instruction, and facilitate students to comprehend the learning material [26].
Based on all the above characteristics, researchers considered the significance of LKPD based on RME development which can accommodate characteristics possessed by students into a better improvement of learning process. LKPD learning based on RME will lead students to be more active in solving problem. For the students who prefer to work individually, this LKPD based on RME will also lead them to construct their own knowledge independently.
4. Conclusion

This is a development research aimed to produce learning device based on RME. The resulted learning devices are RPP and LKPD which are valid, practical, and effective in improving students’ mathematical reasoning ability. The development of learning device based on RME for class VII students of Junior High School level is conducted through Plomp development model research which consists of many activities such as needs analysis, curriculum analysis, concept analysis, and student analysis. The result of needs analysis is the characteristics of expected learning device, learning device based on RME in the form of lesson plan (RPP) and student worksheet (LKPD). The result of curriculum analysis revealed that there is no any change of the established KI and KD. However, the changes took place in the form of indicator, purpose, and learning material. The result of concept analysis is concept mapping in the form of learning material required in the development so that learning indicator can be achieved. Next, the result of student analysis is the adjustment of learning device characteristics and students’ characteristics.

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