Code: P-35

DESIGN OF TEACHING MATERIALS BASED ON REALISTIC MATHEMATIC EDUCATION (RME) TO IMPROVE STUDENTS CREATIVE THINKING ABILITY

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ABSTRACT

This designing is based on the fact that the teaching materials that can improve the creative thinking ability of students through Realistic Mathematic Education (RME) are unavailable. These materials are essential because the learning process that facilitates the development of creative thinking skills could challenge the students to optimally develop their potential thinking. Also, the mathematics teaching materials that are appropriate and the presenting of the mathematics problems that are interesting and challenging, such as the problems related to daily activities, could produce a high quality learning process. The objective of this study is to develop teaching materials based on RME that are valid, practical, and effective to develop mathematical creative thinking ability of junior high school students. Through these teaching materials, students are expected to be benefited, namely (a) mastering the mathematics materials, (b) increasing creative thinking abilities (CTA), and (c) understanding the benefits of mathematics for life. The method used in this design is refers to the development research. The development of teaching materials in this paper is in the preliminary study stage where the materials entering the design stage (prototyping).

Keywords: *design of teaching materials, creative thinking, Realistic Mathematic Education (RME)*

INTRODUCTION

Learning is a process of development of various components systematically and systemically. To improve the quality of mathematics learning, it needs a high quality learning tool, which in this case is called teaching materials. However, the teaching materials that are facilitating the development of creative thinking ability through mathematics learning have not been developed yet. The observation on mathematics books that are available today shows that many of those books give less attention to the development of cognitive mental condition and the potential thinking of students with various backgrounds and characteristics. Those books are not only capturing less contextual issues related to the students' daily activities, but also more mechanistic. As a consequence, those books become less varied in challenging the students to train their thinking ability. This fact makes mathematics class be a difficult subject, and therefore fearing students (Yasmin, 2007: 5).

Way of thinking with regard to mathematical process (doing the math) or the way of thinking in solving mathematical tasks (mathematical task) either simple or complex the basis of mathematical thinking. Terms of mathematical ability, can be interpreted also as the ability to perform mathematical thinking (Sumarmo, 2010). Based on the

depth or complexity involved mathematical activity, mathematical thinking can be classified into two types, namely low-level (low-order mathematical thinking or low-level mathematical thinking) and a high level (high order mathematical thinking or high-level mathematical thinking). According to many mathematics educators, to train the students 'ability to think it must be confronted with problems that are challenging students' thinking skills by encouraging students as a good problem solver.

The 2006's Curriculum Competition Standard states that mathematics must begin to be taught to all primary school students in order to build their logical, analytical, systematic, critical, and creative thinking ability as well as cooperative ability. Those competencies are needed by students so that they have abilities to achieve, manage, and utilize knowledge in order to survive from the dynamic, uncertain, and competitive conditions (Depdiknas, 2006). Creative thinking ability is a capability part of the six dimensions of cognitive processes, which are: knowledge, comprehension, application, analysis, evaluation, and creative thinking (Anderson & Krathwohl, 2001: 67-68). The creative thinking ability is the highest cognitive thinking process and is one of the objectives of mathematics learning.

One of the goals of mathematics learning is to develop creative activities that involve imagination, intuition, and discovery, by developing divergent thinking, originality, curiosity, prediction and conjecture, and trial and error. The creative thinking ability will grow well if the students are learning based on their own initiative, are given a confidence to think, and are daring to state new ideas. The mathematics creative thinking ability gives more emphasis on four aspects, namely fluent thinking skills (fluency), flexible thinking skills (flexibility), original thinking skills/novelty (originality), and elaborate skills (elaboration) (Munandar, 1999: 88). Creative thinking in mathematics and in other areas is part of life skills that need to be developed especially in the era of globalization and increasing competition. Individuals who trained creative thinking ability will grow up healthy and able to face the challenges in life.

The learning process that facilitates the development of creative thinking skills could train students to optimally develop their potential thinking. In fact, the mathematics learning process is still not facilitating the establishment of this capability on students. However, from research studies, researcher found that the creative thinking ability of students in some elementary schools in Palembang had not achieved the expected goals, whether it was measured by the average of all students' grades or by the average of each indicator of the students' mathematics creative thinking ability. Some opinions about creative thinking ability show that it could be fostered through teaching materials designed by a teacher so that these materials could challenge students to explore all of their capabilities that exist within them. To achieve this objective, teachers need to use the appropriate mathematics teaching materials.

Teaching materials are a set of materials arranged systematically in written or other forms so that it creates an environment/condition that enables students to learn (Depdiknas, 2006). The appropriate mathematics teaching materials and the presenting of mathematics problems that are interesting and challenging, such as the problems related to daily activities, could produce a high quality learning process. The students' interest on a particular problem could train them to arrange the various informal or formal strategies on their own discovery based on their

knowledge or the teachers' guidance. The learning process could also be taught by using the interesting mathematics teaching materials and by challenging the students' thinking process through the use of contexts associated with their daily activities. Through these teaching materials, the students are expected to involve actively in the learning process, understand the usefulness of mathematics, and master the mathematics concepts, so that they become creative in solving the mathematics problems as well as the other problems. In addition, the selection of teaching materials must refers to a competency standard. These materials, that are selected by teachers in one hand and have to be thought by students in the other hand, should contain the materials that actually support the achievement of the competence standards and the basic competencies (Depdiknas, 2006).

Realistic Mathematic Education (RME) is a learning theory developed by Hans Freudenthal in the Netherlands since the 1970s. RME is the learning theory that comes from the real things or the students' experiences. This theory emphasizes on process, discussion and collaboration, and debate skills so that the students could solve the problems by their own effort, which in turn they could use mathematics to solve their daily life problems both individually as well as in a group.

RME begins the learning process by using the students' phenomena and real application, where the given problems are the contextual problems. In solving these problems, the students are constructively guided by the teachers until they understand what concepts they learn, by rediscovering the concepts and formulas of mathematics. This rediscovery is conducted by the investigation activities. This kind learning process could attract the students' attention in studying mathematics and develop their creativities about the benefits of mathematics in their life activities (as tools of problem solving). If the students do not study mathematics well, the mathematics material would not be useful in their daily life.

Gravemeijer (1994:91) argues that there are three key principles of realistic mathematics learning, which are as follows: (1) **Guided reinvention and didactical phenomenology**, guided reinvention means that in learning mathematics, students should be given the opportunity to experience the same process as the mathematics were found, (2) **Progressive mathematization**, means that the conditions consisting of phenomena which become materials and application areas used in the mathematics learning should come from the real students' condition before they reach a formal mathematics level, and (3) **Self-developed models**, means that the role of self-developed models are as a bridge for the students in connecting the real situation to the concrete situation or connecting the informal mathematics to the formal mathematics. This means that the students create their own model to solve the problems. The first step is that the students create a model of a situation that is close to their nature. By generalizing and formalizing, this model will be changed to the 'model of' the problem. The 'model-of' will then become the 'model for' the similar problems. Eventually, the model will become a formal mathematics model.

The RME theory, according to de lange, Treffers, and Gravemeijer (Zulkardi, 2002:30-32) has five characteristics, which are as follows: (1) **using contextual issues**, means that the contextual issues are used as the application and the starting point from which the desired mathematics problems may arise, (2) **using a model**, means that a model becomes a bridge with the vertical instrument, where the students' attention is directed to the development of the model, schema and symbols rather than only

directly transferring the mathematics formula, (3) **using the contributions of students**, means that a major contribution in the teaching and learning process are expected from the students' own construction, that leads them from the informal methods to the formal or standard methods, (4) **interactivity**, means that the important factors in the constructive teaching and learning process are explicit negotiation, intervention, cooperation, and evaluation within the students and the teachers, where the students' informal strategy is used as the basis to achieve the formal one, and (5) **integrated with other learning topics**, the holistic approach suggests that the learning units cannot be achieved separately because the connection and the integration must be exploited in the problem solving.

The problem is that how to design the teaching materials that can train and improve the students' creative thinking ability based on RME by utilizing the daily life problems in the mathematics learning? To solve these problems, this research aims to design the teaching materials that enhance the mathematics creative thinking ability of students. The main purpose of this research is to design the mathematics teaching materials based on RME in order to improve the students' mathematics thinking ability. Included in these teaching materials are the Student Activity Sheets, the Teacher Books, and the Lesson Plans. The developed materials are the materials discussing fractions that are taught at the seventh grade of Junior High School.

The method used in this research refers to the development research with two main stages which are the preliminary study stage and the formative study stage (Akker, 1999). The development research in this paper is the preliminary study stage based on the principles and characteristics of RME in order to improve the students' creative thinking ability, which is:

(1) Preparation; this stage includes the analysis of mathematics curriculum materials based on students' creative thinking ability at junior high school level.
(2) Designing the teaching materials (prototyping); this stage includes the design of teaching materials based on RME which could train students' creative thinking ability.

The design of these teaching materials also refers to the principles of the creation of teaching materials published by the Ministry of National Education (Depdiknas, 2006). The principles of the selection of teaching materials include: 1) **relevance principle**, meaning relatedness. The teaching materials should be relevant, related, or connected to the achievement of the competence standards and the basic competencies, 2) **consistency principle**, meaning constancy. If the basic competencies that must be mastered by the students are four things, the teaching materials that must be taught are also four things, and 3) **sufficiency principle**, meaning that the teaching materials should be adequate to help the students in mastering the basic competencies.

RESULTS AND ANALYSIS

The stage that has been undertaken in this development is the preliminary stage.

(1) Preparation
This stage begins by analyzing the curriculum based on KTSP and the standard of mathematics content for seventh grade of junior high school, analyzing the characteristics of junior high school students, and analyzing the textbooks

circulated the market. The results from the informal interview with some mathematics teachers, the Figure of the students' ability in answering some questions, and the study of the researcher about the teaching material and its relation to RME approach give a consideration that the developed materials are the fractions materials on the seventh grade of Junior High School. The researcher designs the teaching materials based on the relevant characteristics for the seventh grade students which are the first-year students at a Junior High School. The researcher also analyzes which contexts are suitable to them and pretty close to their daily activities, and designs the activities that could develop various aspects of their creative thinking ability.

(2) Designing of materials teaching (prototyping)
The results of this stage are the teaching material drafts, which one of them is the Student Activity Sheets (SAS). The developed materials are fractions and the basic competency is to use the properties of arithmetic operations of integers and fractions in the problem solving. This teaching material draft is designed by considering the characteristics of RME where the activities and the questions could explore the students' creative thinking ability which emphasizes four aspects: fluent thinking skills (fluency), flexible thinking skills (flexibility), original thinking skills/novelty (originality), and elaborate skills (elaboration).

Integration Aspects of Creative Thinking on Student Activity Sheet (LAS)

The appearance of the contexts characteristics in the SAS begins with a contextual problem that must be solved by the students. Here are examples of issues raised in the SAS:

> At the time of Riri's birthday, his mother bought a cake. At the anniversary event, while cutting the cake, the cake will be distributed to her friends and family. Half of the cake for her friends, for her parents one-eighth part, and the sides will be eaten by

In a matter of solving the above problems raised students' everyday environment context or real (realistic) in the sense that not only invisible (concrete) but invisible to the mind (which, though abstract, but it is accessible to students mind). By solving the given problem, students are trained through the concept of original thinking skills or knowledge that they have had before. Through these two characteristics, the model that the students should be the model that moves up, from the concrete to the abstract model of the model, so that it can be seen how the student thinks and the change (increase) the way students think. Here's one example of the student activity:

> Take two sheets of paper. Divide that paper to all members of the group so that every member get the same parts. How do you share it? How many part of paper that

This problem is designed so that it could obtain various forms of the students' answers. By doing so, this problem solving process could train the students' original thinking skills. The use of the model is implemented on the student activities as a bridge in shifting the students' concrete thinking to their abstract thinking in which the students are expected to understand the meaning of fractions more flexible. With a question that asks students to explain how they divide the paper with the same part

will encourage students to elaborate on each step they did. This activity is designed to stimulate the students' contribution in constructing the concept of fractions. By doing so, the students are expected to train their fluent thinking ability because they interact with other students and with the teachers through the process of discussion, negotiation, and communication. These characteristics through the increase of creative thinking skills will be enhanced by the process of discussion among students that can sharpen their knowledge. From start to finish learning activities with the guidance of teachers, students continue to be trained creative thinking skills through the issues and activities that challenge students to put the students as a problem solver.

This SAS is also equipped with the exercise questions in the form of the contextual questions close to their daily life which explore their creative thinking ability. The questions used in this SAS include the open questions with detailed answer as the explanations as part of the indicator of the mathematics creative thinking ability. These contextual questions also imply the relationship between topics and other mathematics concepts, as well as other areas of knowledge.

Eventually, this teaching material draft will then be passed the validation process and the next development stage (Formative Study) in the form of the evaluation through validation process, trial run, and revision so that it could produce the valid, practical, and effective teaching materials.

CONCLUSIONS

The researcher's findings from the Figure of the achievement of the seventh grade of Junior High School students in answering the mathematics questions show that the students' ability in solving the non-routine mathematics questions related to fractions is very weak. In addition, the textbooks that train students to think creatively in answering the questions are still rare in the markets. On the other hand, the learning activities conducted in the class have also not accommodated this ability. The creative thinking ability could be fostered through a study designed by the teachers so that it could train the students to explore all capabilities that exist within them. To achieve these objectives, the teachers need to use the mathematics teaching materials that could train the students' creative thinking ability. Since this ability is essential to be developed for students, need to be supported through instructional approach that facilitates students to exercise their creative thinking skills. *Realistic Mathematic Education* (RME) approach is using the real students' phenomena and application by providing the contextual problems. The rediscovery of the mathematics concepts and formulas are conducted through the investigation activities. Such learning process could attract the students' attention to study mathematics and develop their creativities about the benefits of mathematics on their daily life (as tools of problem solving). The design of this teaching material is expected not only on one subject, but also could be developed on other subjects and at the higher grades.

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This paper can be cited as Zulkardi(2013). Proceeding The First South East Asia Design/Development Research (SEA-DR) International Conference, Sriwijaya University, Palembang, April 22nd-23rd.