ME – 09

The Excellence of Realistic Mathematic Education based on Gardner's Multiple Intelligences Theory through Mathematical Connection Ability

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***Abstract*—**The aims of learning mathematics is to develop various aspects. One of them is cognitive. One important ability of students'cognitive aspect in learning mathematics is mathematical connection. Therefore, we need a method to develop student's mathematical connections. In mathematics, one method that can be used to develop student's mathematical connection is RME (Realistic mathematic education)-based Gardner's multiple intelligences (MI). RME can be defined as an approach in learning mathematics using realistic situations or problems in the learning situation so that students understand mathematical concepts. In RME-based multiple intelligences by Gardner, teachers provide realistic problems and diverse learning activities in every meeting. How RME-based Gardner's MI can develop students' mathematical connections in mathematics? This paper will give an explanation through the study of literature.

Keywords: *mathematical connection, realistic mathematic education, Gardner's multiple intelligences*

I. INTRODUCTION

One of the efforts to improve the human resources quality is education. Learning in school is way to realize it. One of the compulsory subjects taught in school is mathematics. In fact, the acquisition of Indonesian student in math scores is low. Based on the results of the Programme for International Student Assessment (PISA) in 2012, Indonesia ranks 64 out of 65 participating countries with an average acquisition in mathematics is 375 [2]. PISA is intended for students in the age range of 15 years.

National Council of Teacher of Mathematics state 5 standard reference processes that need to be studied in mathematics, i.e mathematical problem solving; mathematical reasoning and proofing; mathematical communication; mathematical connections; and mathematics representation. One of the skills that students need to have in learning mathematics is the mathematical connection. Therefore, it is very possible that the low math achievement of students is caused by lack of mathematical connections. Students with high math connection capabilities will easily solve a math problem because basically the mathematical concept has been linked one to another.

There are many things that can be done by teachers to improve student mathematical connections. One of them is learning approach. In choosing a learning approach, teachers need to pay attention on student characteristics. Realistic Mathematics Education (RME) approach is still relevant to be applied for junior high school students who are the concrete operational thinkers or even just starting to formal operational thinking [4]. RME is a math learning approach which is first introduced and developed in the Institute Frudhental Netherlands in 1970. This learning approach originates from two main ideas of Hans Frudhental i.e mathematical problems should be linked to realistic context and mathematics as a human activity.

In addition, each individual in the class has a variety of intelligence that can not be overlooked in learning. There are students that are easier to learn with music, some of them like learn mathematics with pictures, some like to learn in groups, and so forth. It is associated with Howard Gardner's theory on MI.

Learning using Realistic Mathematics Education approach based on Multiple Intelligences theory needs to be applied. RME is expected to increase mathematical connection ability and multiple intelligences theory makes students enjoy studying mathematics, so it is easy to accept.

Theoretically, how could Realistic Mathematics Education based on the theory of multiple intelligences develop students' mathematical connection capability? The explanation on the matter is expected to give an idea how to develop students' mathematical connections through Realistic mathematics education approach based multiple intelligences theory as well as how to implement it in the teaching learning mathematics.

II. DISCUSSION

A. Realistic Mathematics Education (RME)

RME is one of mathematics approaches which was first introduced and developed in the Institute Frudhental the Netherlands in 1970. The learning approach originates from two Hans Frudhental's main ideas that mathematical problems should be linked to realistic and mathematics as a human activity. This approach uses realistic problem to help students construct mathematics concepts. The problem is not always the realistic one that exists in the real world (real world problem) and can be found in student's daily life. A problem is called realistic if it is imaginable on student's mind. Meanwhile, as the activity, students should have the experience or the opportunity to do the experiment to construct their knowledge [5].

Learning using RME should contain the characteristics of the approach. Treffers in [6] mentioned 5 characteristics of RME, as follows:

1. Context Use

   Context is a bridge for students to understand mathematical concepts. Context used as a realistic problem should be imaginable for students.
2. The use of mathematical models for Progressive mathematization

   Refers to [7] RME is a model of learning that guides students from the informal into formal knowledge. Students face contextual issues then a model is developed based on the issues. Next, the model will be developed using mathematical reasoning in order to obtain formal mathematics.

   The process above is called mathemazation. [8] argues that the mathematization is the process leading to the mathematical concept from the real problems which are close to students' lives. There are two types of mathematizations: *When this actively of mathematizing applies to a subject matter of reality, we call it horizontal , and when it applies to a mathematical matter one speaks of vertical mathematization.*

   It can be concluded that the mathematization is a process of informal to the formal mathematics. Based on the classification, horizontal mathematization directs students to identify the real context and translate it into mathematical language to make it more understandable to complete. Vertical mathematization also rests on contextual problem until it can arrange a specific procedure to resolve the problem without starting by context.
3. The Utilization of Student's Construction

   Mathematics is not a finished product. Students are given the opportunity to construct knowledge through exploration. The results of their findings are the basis for building a mathematical concept.
4. Interactivity

   Group activities, the indirect negotiations, and discussions are very important activities in the process of knowledge construction. It is an informal method for students in acquiring formal knowledge.
5. Intertwining

   Single mathematical concepts are not enough to apply the concepts and problem solving. Intertwining is needed in solving mathematical problems.

B. Multiple Intelligences(MI)

Intelligence is the ability to apply knowledge and experience to face the challenging tasks flexibly [4]. Howard Gardner [9] stated that, *Intelligence is the human ability to solve problems that are valued in at least one culture*. Furthermore, refers to [10] states that MI are the ranges of students' skills and talents to solve problems in learning process. In conclusion, intelligence is the ability to solve the problem that could be different from one person to another. This is talent as well.

Howard Gardner, in his book "Frames of Mind", suggests that there are nine kinds of intelligence of human beings that form multiple intelligences. Here are nine multiple intelligences, the characteristics, and ways to employ in teaching-learning process:

1. Verbal-Linguistic intelligence
   People who have this intelligence tend to have a high ability in reading, writing, and talking. In mathematics, students can be encouraged to understand certain concepts through poetry.
2. Logical-mathematical intelligence
   People who have this intelligence have the ability to make mathematical calculations, deductive and inductive reasoning, build logical relationship, to propose hypotheses, to solve problems, to think critically, and to understand the numbers, geometric shapes, and abstract symbols.
3. Visual spatial intelligence
   Visual spatial intelligence is the ability to make visual representation in mind, or the ability to dream, to imagine, to think with drawings, lines, shapes, and so forth. Teachers can present learning materials in graphs, pictures, and diagrams to make visual spatial students more easily understand.
4. Musical-rhythmic intelligence (musical intelligence)
   Musical intelligence is related to rhythm, sound, tones, and music. Children who have musical intelligence has ability to play an instrument, to sing a song and write songs. To facilitate students with musical intelligence in learning mathematics, teacher can introduce the mathematical material through song.
5. Bodily kinesthetic intelligence
   Bodily-Kinesthetic intelligence is an ability to move, make gesture and facial expression, using the effective coordination between brain and body, and produce all or part of the body movement. In mathematics, this intelligence can be facilitated with a hands-on activity and by letting the child learn with some learning instruments.
6. Intrapersonal intelligence
   Interpersonal intelligence is the ability to understand and distinguish emotions, aspirations and needs of the environment. To facilitate this intelligence, teacher can use some cooperative model learning.
7. Intrapersonal intelligence (intrapersonal intelligence)
   According to Gardner, intrapersonal intelligence is the kind of intelligence that is the most important in life. It is enables person to understand and be responsible with theirself. Students with this intelligence can be given the opportunity to learn on their own first before learning in groups.
8. Naturalistic intelligence (naturalist intelligence)
   It is the ability to identify and find objects in nature and thinking life form. Outdor learning is one way to facilitate students with this intelligence.
9. Extensialist Intelligence
   Ekstensialist intelligence is the ability to question everything. Intelligent people tend to question why something happens, the reason of some event, and curious about everything. To facilitate the students with this intelligence, teachers need to understand and prepare the answers of teaching materials [11].

C. Mathematical Connection

Mathematics is often seen as as an unrelated set of skills or activities. A person who visualizes math only as a collections of facts, capabilities, and procedures will find it hard to achieve a deep understanding of mathematics. Mathematics is not a collection of separate topics, but a thorough knowledge and mutual connections [12]. Refers to [3] defined five standard capabilities that must be possessed by students in learning mathematics: problem solving, reasoning, communicating, making connections, and making representations.

Mackanong in [13] states that "mathematical connection was learners' abilities to link the previous of their mathematics knowledge and problems gained from classes to the current problem or situation with the which they were dealing." This means that the mathematical connection is the ability to connect the mathematical knowledge they already have in long-term memory into a situation or problem they are facing.

Hiebert & Carpenter in [14] suggest that making a connection process in mathematics is the core of developing mathematical understanding. Teacher should facilitate students to make connection so that students can find meaning in learning. Refers to [15] state that a student will actually have a relational understanding (knowing what to do and why) in the learning process if they do not just memorize or remember the material being taught, but also can connect the concepts or new procedures with ideas owned

by the students beforehand. Mathematical connections allows students and teachers to discover mathematics in daily life, especially everything related to the life and interests of students, the relationship between mathematical concepts and mathematical relationships with subjects or other disciplines [16].

Based on [17] argues that the correct relation can build conceptual understanding. The more powerful students make connection between interrelated concepts, then the understanding gained will be deeper and richer. In essence, a person will gain an understanding of new concepts and build it through connection with the previous concept. The person will add and develop an understanding of the new concepts as well.

Refers to[3] states that a person is able to perform mathematical connection, if: (a) be able to recognize and use connection among mathematical ideas; (b) understand how mathematical ideas are interconnected and built on one other to produce a coherent result; (c) recognize and apply mathematics in contexts outside of mathematics.

According to [18] study of mathematics will be effective if the learning process facilitate students to do some of the connections as follows:

1. Establishing a connection between student's initial knowledge with concepts and new abilities.
2. Connecting intuitive knowledge with formal mathematical/ abstract.
3. Connecting several mathematical representations, concrete activities, the language of mathematics, and certain symbols.
4. Connecting between topics in mathematics.

The characteristics of people who have mathematical connection ability can be identified, as: capable to connect mathematical concepts or mathematical ideas that students already have into mathematical problems being faced, capable to connect some concepts or mathematical ideas that students already have into the contextual issues that related to daily life, and capable to connect concepts or mathematical ideas that students already have into the problems associated with other disciplines. From some of these characteristics, the mathematical connection indicators are as follows:

1. Connecting concepts or mathematical ideas with mathematics problems.
2. Connecting concepts or mathematical ideas to problems in the context of everyday life.
3. Connecting concepts or mathematical ideas to problems in the context of other disciplines.

D. The Excellence of Realistic Mathematic Education based on Gardner's Multiple Intelligences Theory through Mathematical Connection Ability

RME has five characteristics. One of the characteristtic is the ability to connect the realistic problem with the students previous knowledge. RME approach that emphasizes problem solving can not be separated from the connection process. RME with realistic problems require students to be able to resolve the problem by changing into a mathematical form, and connect the problems with the mathematical concepts owned by the students. Multiple activity based on multiple intelligences will help students develop the mathematical connection capabilities. It aims to connect their activities with the concepts they learn. The activities will vary significantly if students can relate to the mathematical concepts that are being or have already learned.

According to [19] argues that to facilitate students connection, mathematic teacher should be able to encourage students to undertake investigative activities, link mathematics, to facilitate the students to be able to select the appropriate method to give a reason and idea, and to judge their decisions in resolving a problem. RME is the best approach because it enables students to explore, to connect concepts with methods/strategies as appropriate, as well as to provide ideas in group discussions. In conclusion, RME approach based on multiple intelligences theory can promote students mathematical connection.

Here are the steps that teacher can practice in the teaching and learning mathematics.

1. Understanding realistic problem
   Teacher given the realistic problem to be understanding by the students. The realistic problem should be in multiple context. Multiple context will facilitate the students with multiple intelligences. In this phase, teacher give a simple explanation about the problem to the students.
2. Solving the realistic problem
   Teacher can facilitate intrapersonal or interpersonal intelligences in this phase. Teacher give a chance for students to think individually or by group discussion to solve the problem, and using students logical mathematical intelligences to make mathematical modeling about the realistic problem to get the solution. In this phase, students have to make connection about the problem and the concept they should use to solve the problem. This also can promote students mathematical connection.

3. Comparing Result and Making Conclusion
   In the last phase, students have to present their discussion in the class, comparing with the other, and teacher clarifying the correct result. And last, the students and teacher making conclussion about the topic, what they have learned. This phase is appropriate with the interactivity principal of RME.

Here is the example of realistic problem about area of circle that related to the the concept of area of rectangular and the concept of arithmetics.

"*A rectangular garden in Yogyakarta have dimension 15 meter × 9 meter. There is a fountain pool in circle shape in the center of the garden. The diameter of the pool is 9 m. That garden will be palted with the grasses except the pool. If the cost needed is Rp105.000,00 for every 1 meter square, determine the whole cost to plant the grasses.*"

To solve the problem above, students have to connect the real problem to the mathematical concepts, and also have to connect the concept of area of circle with another concept, such that area of rectangle and social arithmetics.

III. CONCLUSION

Realistic mathematics education approach based on Gardner's multiple Intelligences theory can make student's mathematical connection ability excellent. Therefore RME learning progress should contain 5 characteristics including intertwining. That means, one material should be connected with others and students should have mathematical connection ability to do that. The mathematics materials are found by an exploration and mathematization progress, so they will not memorize only but also understand. Furthermore, learning process based on Gardner's multiple intelligences will make students enjoy because they learn with various activities they love.

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