

## Indonesian primary school teachers' challenge in learning RME's teaching approach

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*This study examine the learning practice of two selected teachers, Evin and Amar in two different in-service program in 2008 and 2010 with aimed at exploring Indonesian primary teachers' learning process on designing Realistic Mathematics Education (RME) lesson and the challenges of learning RME approach. RME is a theory in mathematics education that offers a pedagogical and didactical philosophy on mathematics learning and teaching. Two important points of mathematics related to RME by Freudenthal are mathematics must be connected to reality and mathematics as human activity. We draw upon data from the teacher's learning practice in two different in-service programs held in 2008 and 2010. Researcher did the observation to selected teachers and interviewed them throughout the program to inform on their learning practice and the challenges they faced in learning and designing RME's lesson. Those two teachers experienced different learning process that are analysed using Mason et. Al phases (2010) and they had different thinking and challenges on the designing RME lesson. Evin's challenge was on the mathematics knowledge and the design was consistent with manipulative mathematics, while Amar's challenge was having superficial understanding on the RME's approach and has similar design which still introduce algorithm on the book within the context and media used.*

*Keywords: RME, Teachers' challenge, Teachers' learning*

### INTRODUCTION

There is a number of study that consider the teachers' classroom practice (Borko, Eisenhart, Brown, Underhill, Jones & Agard, 1992; Drake, 2000; Huberman, 1993; Leinhardt, 1989; Leinhardt & Greeno, 1986; Shealy, 1994; Shealy, 1995; Sherin & Drake 2000; Wilson, Shulman, & Richert, 1987 in Barrett, Jones, Mooney, Thornton, Cady, Guinee and Olson (2002)). In the classroom practice, mathematics teachers have the responsibility to encourage students' learning. Nevertheless, Lin and Ponte (2008) suggested that teachers and prospective teachers are also learners. The learning practice can be done in informal situation such as in-service program In Indonesia, there is an implementation of Indonesia version of Realistic Mathematics Education (RME), labelled as PMRI. It is an innovation and new approach aiming at enhancing the students performance and it is also a new way of thinking about the practices of school mathematics.. Moreover, according to R.K. Sembiring et all (2008), it is also need to be recognized that it has not been easy to implement PMRI theory and approach in the

teaching and learning of mathematics in Indonesian school. It is due to the teaching approach that common appear in Indonesian mathematics classroom is teacher-centred practice, whole-class teaching and transmission of knowledge by teachers. Some teachers have not embraced the PMRI's philosophies, and have not adopted the recommended the teaching approach but these are the minority, and most have developed positive perception of PMRI and have to come view it as an alternative method likely to be needed mathematics reform of school (Sembiring et al, 2008). We assume that these some teachers found some challenges with RME teaching approach. In this paper, we describe our findings of the challenges that teacher faced in learning RME approach. These primary teachers' challenges becomes essential sources for teacher educators to develop learning community program for RME or other approach for their professionalism. We start with the brief description and discussion about research of and framework on Realistic Mathematics Education(RME) as the reformatinal learning approach in Indonesia and the in-service program. Moreover, phase of work by Mason and his colleagues is also posed as framework for analyzing and describing teachers' participation on their learning practice. Furthermore, through discussion in the learning practice and one on one interview is used as strategy to explore the challenges the teachers face. Detail analysis of teachers' responses and participation in the professional development program found are elaborated. To be more specific, this study asked the following questions: (a) How is the teachers' learning practice of RME designed? (b) What is the challenge teachers' face in learning RME approach?

## **BACKGROUND AND LITERATURE REVIEW**

### **Realistic Mathematics Education (RME)**

RME is a theory of mathematics education that offers a pedagogical and didactical philosophy on mathematical learning and teaching as well as on designing instructional materials for mathematics education (A. Bakker, 2004). It is a mathematics approach that was developed in the Netherlands based on the idea of Freudenthal (1991) on mathematics that mathematics as human activity and mathematics must be connected to reality. Mathematics must be close to children and be relevant to everyday life situation, so we need to develop contextual situation that is relevant to and familiar to students. They should experience the meaningful of mathematics learning instead of become used to be spoon-fed by their teachers. In the RME, the role of the teacher is not to lecture or transfer mathematical knowledge, but create situations for students that will encourage them to make the necessary mental construction. There are three principles of RME such as (1) guided reinvention and didactical phenomenology, (2) progressive mathematization and (3) self-developed models. Based on the three principles of RME, there are five characteristics of RME related to the mathematics teaching and learning (Treffers and Goffree, 1985) :

- (1) phenomenological exploration or the use of contexts;
- (2) the use of models or bridging by vertical instruments;
- (3) the use of students own productions and constructions or students contribution;
- (4) the interactive character of the teaching process or interactivity;
- (5) the intertwining of various learning strands.

Furthermore, Van den Heuvel and Wijers(2005) explained about the principle of RME mathematics teaching. There are 6 principles of mathematics teaching that each reflecting specific characteristic of the identity of RME. It is an adapted version of the five tenets of framework for the RME Instruction theory distinguished by Treffers (Van den Heuvel and Wijers (2005):

**Activity principle:** Van den Heuvel and Wijers (1995) defines activity principle has meaning that students are confronted with problem situations in which they can develop algorithmic way of mathematics concept based on informal way of working.

**Reality principle:** In RME, the realistic problem that refer to the reality principle are not recognizable at the end of the learning process. Reality is as source for learning mathematics. Therefore, instead of posit it in the end and the learning process start with abstract things, the learning process should start with rich realistic problems that can be mathematized.

**Level principle:** (Gravemeijer, 1994; Gravemeijer, Cobb, Bowers, and Whithenack, 2000, Gravemeijer, 1999 )described four types of activity which it might be denoted as level: Activity in task setting which students should understand and interpret the contextual situation; *referential* activity, in which models-of refer to activity in the setting described in instructional tasks; *general* activity, in which an orientation on mathematical relations and strategies make it possible to act and reason independently of situation-specific imagery; more *formal* mathematical reasoning, which is no longer dependent on the support of Models-for mathematical activity.

**Intertwinment Principle:** Mathematics concepts are interconnected each other and the mathematics concept and discussion in the classroom environment usually includes some related concepts. The integration of some lesson unit should be investigated to encourage the meaningful learning and teaching process.

**Interaction Principle:** The classroom participation structure is established jointly by teacher and students and also among students. The interaction in the classroom practice would allow students to do reflection about their thinking. In RME, however, there is a strong preference for keeping the class together as a unit of organization within which a variety of teaching methods can be applied; ranging from wholeclass teaching to group work to individual work (Van den Heuvel and Wijers, 2005).

**Guidance Principle:** Freudenthal (1991) argued that in teaching mathematics, where strategy attainment is considered as a process of 'guided reinvention' to 'reinvent mathematics'. He believed that students should be given the opportunity to reinvent the discoveries of our forefathers.

The six principle for mathematics teaching under RME approach above may guide teacher in designing RME's lesson. Teachers need to understand each principles of RME's teaching. For some teachers in Indonesia, this knowledge is new and in order to develop teacher understanding of designing RME's approach, Indonesian researchers need to engage teachers in learning community forum such as in-service program for teachers.

### **In-Service Program for teachers**

We propose the teachers as learners in the program. Lesh and Kelly (2000) suggested that design should involve different tiers of participants, which cooperate in an interactive nature linking research and practice to solve problems encountered in classrooms. To be more specific, Lin, Hsu, Yang, Chen (2012) described that the transfer of knowledge from educators, teachers, to students in professional development is not linear and one-way process in which the solutions to problem encountered in teaching and learning can be directly obtained. Therefore, teachers need to coordinate the knowledge gain from teacher professional development program and transform to the classroom practice. Those knowledge's coordination and transformation are also part of teachers' learning of RME.

### **Methodology**

We selected one teachers called Evin<sup>1</sup> who has 4 years teaching experience to be observed in learning RME in 2008 with three other novice primary teachers in a school and one experience teacher Amar<sup>2</sup> who has 20 years experience who follow the

in-service professional development program in 2010 with other 8 primary teachers from different school. Those teachers had no knowledge about RME before they learn in the learning environment. Evin was chosen because she had high motivation in learning the RME approach and she is also a novice teacher. Furthermore, Ama is chosen due to her enthusiastic in proposing her ideas and experiences in the learning practice and she is very confidence with her teaching. The learning practice program are described below:

Year Program	Description of the program
2008	<ul style="list-style-type: none"> <li>- Observed the modelling teaching with RME approach in real classroom practice by first author</li> <li>- Workshop of discussion RME design lesson</li> <li>- Had plenary speech with a Professor about the theory of RME</li> <li>- Did teaching practice on RME approach collaborate with</li> </ul>
2010	<ul style="list-style-type: none"> <li>- Workshop of designing lesson with RME approach</li> <li>- Modelling the RME approach by experience teacher of RME in front of teachers participants</li> <li>- Modelling and discussing RME approach teaching by educator</li> <li>- Plenary Speech about RME approach by educator</li> <li>- Teaching practice of RME by teachers participants</li> </ul>

There is a difference in the learning process of those two program. In the program of 2008, teacher were asked to observe first the modelling lesson by educator in the real classroom with real students and continue to others activity. The lesson design of RME that modelled by educator was about equivalence of fraction using double bar model. In other hand, in the program of 2010, teachers had workshop on designing lesson first before they did observation on the modelling teaching based on RME and other activities. They discussed the lesson that they made with other teachers. The modelling of mathematics teaching is about multiplication concept by educators and ordering number by RME's experience teacher. The modelling activity by the experience teacher on RME and educator held in front of the participated teacher and assume those teachers as students. During the professional development program, the design lesson was presented and other teacher might share their thinking about the design and can give any suggestion. An interview was also conducted to get more review of teachers' understanding of realistic mathematics education and the relation to their teaching. Other data of professional development session are video recording of workshop, classroom teaching and field notes taken by research assistant. Moreover, we use analogue the phase of Work of Mason (2010) as framework to analyze the teachers' performance within the teachers' learning practices. The phase of work concerns on process of tackling a question is divided into three phases, called **Entry, Attack and Review**. The entry phases concern on preparing the ground for deciding what the students want to do on the problem. The attack phase should be the most crucial since during this phase, there should be some variation of approach and plan that will be applied for the problem. Moreover, the third phase described by Mason(2010) is the review phase which have three words to construct this phase such as Check, Reflect and Extend. Check the resolution, Reflect on the key ideas and key moments and Extend to the wider context. These phases could be analogued for teachers in the term of teacher professional development program. In the teacher professional development program, teachers are supposed to enter the program, therefore they will be in the entry phase. The third phase that is review phase consider the evaluative results stage by Horsley, Stiles, Mundry, Love & Hewson (2010) where checking and reflecting process concern of the professional development program.

#### **FINDINGS**

The first author (R) facilitated the teacher learning on RME approach in 2008 with three representative teachers in a school and also In-Service Teachers Professional

Development Program for learning RME with eight teachers from three different school in East Java was held in 2010. Those two learning environment have key element on improving teachers pedagogy and facilitate the teachers teaching quality for students' active learning with the sense of RME. The teachers' learning process of two targeted teachers from different period of learning is analyzed using phase of work of Mason (2010). Furthermore, R conducted an interview with those two teachers before they follow the program

*R: Would you please tell me your teaching experience before you follow the program?*

Evin (E)	<i>In teaching the students, what I did was based on the book and I feel that I gave directly to the abstract learning level, just following the book from the library. So in my opinion, what I gave was not for the students' world and I feel that the students were forced to follow my instruction. I really want to know more innovation in teaching through RME</i>
Amar (A)	<i>I use textbook and modified a little bit and i feel i had make mathematics active learning for students. I don't use any media at all. For example, i will teach ordering number, i give example by ask student to make a line assume they have shirt with number and come to the front and guess what shirt number between two student.</i>

From the two responses, we can say that both teachers mostly teach based on textbook and Evin who is novice teacher at that time feel that she was eager to learn RME. Another teacher, Amar has more confidence in teaching using active learning. For her, active learning defined as using students physical movement when learning. We can see that the intention of both teacher on the program is quite different, Evin as novice teacher prefer to have more curiosity to learn RME. Moreover, the deep description of observation on Evin and Amar's learning process are presented below:

Learning activities	Evin	Amar
Entry phase	Full Entry means that she was really eager to learn RME in the learning environment	Entry on the challenge given. She had belief that she already provide active learning to students, however, she intend to learn and follow the activity for learning RME

Attack phase of Evin

In the next phase, teachers start to follow the workshop and discussion of RME and try to design the RME's lesson for students. R pose lesson design on equivalence fraction with 'cake shop' as context and paper folding as the activity for students. R with E and other two teachers discuss the paper folding activity. Evin pays attention on every principles of designing RME's lesson explain by R. Evin recognizes the consistency of the context of 'french cake' and the rectangular paper as model of the contextual situation. But she did not say the term 'model-of'.

E: I see how the movement from the french cake to the rectangular paper for the activity. It is in the similar shape so that we do not use the cake forever to find the idea of equivalence fraction.

To accomplish the idea of equivalence fraction, 'double fraction bars' was chosen as model for exploring the students' understanding and reasoning of equivalence fraction. Next, R challenged to integrate unit lesson of comparing fraction and addition of fractions with unequal denominator within lesson as applying intertwinment principle by keeping the consistency of the model. Nevertheless, Evin showed her difficulties on posing question and instruction that lead students to find the common denominator to add fractions  $2/3$  and  $1/2$ .

E: I usually provide algorithm to students that we need to find the common denominator to add fractions with unequal denominator.

R: Do you know what is the idea behind the need to find the common denominator to add those two fractions?

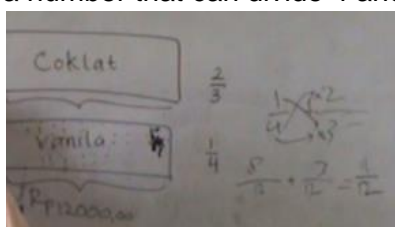
E: These two fractions can be added if they have the same denominator.

R: Is there any relation with the equivalence fraction on the design?

E: I think we need to differentiate the paper folding activity and addition fractions with unequal denominator.

From this transcript, we see that E did not find the relation between the equivalence fractions and its used for addition fractions with unequal denominator. If we analyzed with the level of mathematics problem of fraction by Hart(see Hart,1981), E got difficulty in level 4 which is about question where more than one operation is needed. These situation was also seen in Evin's teaching practice after students learn equivalence fractions with paper folding activity. She tried to explain the addition of  $\frac{2}{3}$  and  $\frac{1}{4}$ .

E: You see that the denominator of  $\frac{2}{3}$  and  $\frac{1}{4}$  are 3 and 4. Pay attention on those numbers and you need to find a number that can divide 4 and 3



Evin tried to guide the students to the algorithm and she shared her difficulty to intertwining the addition fractions within the context. She also shared her challenge to explain the reasoning of the need to make the denominator equal to add the two fractions. But she was mastering the calculation process.

#### Attack phase of Amar

In Amar's learning practice sequence was quite different with Evin which she experienced the workshop first before observing the modelling of RME's lesson. In the workshop, an educator (E) try to explain about RME's lesson especially on the meaning of some mathematics topics and teachers in group are encouraged to design their pre-lesson design in group. Amar and other teachers in group decided to design place value's lesson. In the group discussion, R saw that Amar was quite dominant in the discussion and she shared the lesson by using straws as media.

A: We use straws as media for innovative teaching of 'place value'. We need to make agreement first with students that the red straws represent 'hundreth', the green straw represent 'tens' and yellow straw represents 'units. Then, we ask students to show the straws after we say a number. For instance 273, students will show 2 red straws, 7 green straws and 3 yellow straws. By this activity, we can embed the concept of place value to students'

From that transcript, Amar put more attention on the use of media for developing mathematics concept. However, Amar included the algorithm of introducing place value within the media itself.

After modelling from experience teachers on RME and modelling teaching, Amar got more sense of RME. In the discussion, she posed statements

A: I think we already did the principles in the class but the difference is that the reinvention process. We can not just tell them the mathematics concept but we need to help them reinvent mathematics. This is a quite hard job.

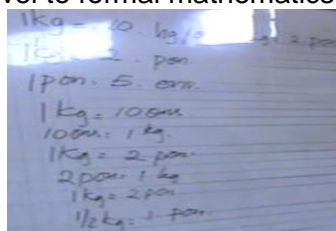
After the discussion and overview about RME, teachers did the teaching practice. In the teaching practice, Amar held the weighing activity with different kind of weight scales to provide reality experience to students. By this activity, she want students to understand

'kilogram' and convert to other unit measurements such as gram, ons and pon. Based on observation, students struggle on reading the weighing scale. The scale show 240 gram, however students read it as 204 gram since there are four unit scale after the 200 gram. This situation make Amar realize that she need to be careful in chosing the tool or model and should introduce the weighing scale properly to students. In other scene, students show their struggle in converting from one unit weighing to other unit weighing and teachers directly told students to convert by using stairs unit when they are still in the weighing activity.

R : What do you think about your teaching practice?

A : I do not know how to go from this weighing activity to the stairs unit. I feel i am in hurry in introducing many kind of measurement unit so that students got confused.

It shows that Amar reflect on her teaching practice and she realize the need of revision in her teaching. The statement she posed implied that she had challenges in the level principle especially moving from general activity level to formal mathematics.



#### The Review phase

In the review phase, teachers did check, reflect and extend of their learning practice of RME. R did one on one interview with Evin and Amar regarding their learning practice including their experience in teaching practice. R started by asking their comment on the modelling process first.

R: What do you think about the modelling of RME's lesson design by experience teachers on RME and educator?

	<b>Evin</b>	<b>Amar</b>
Pedagogical responses on the modelling RME lesson design	She argued that the context presented in the lesson design is close to students world and bring to model afterwards so students experience of the use of mathematics	She argued that the activity presented encourages students to investigate the concept and she feel more variety on teaching and learning opportunity to students.

R: Okay. In the research experiment, you used the RME method in teaching through contextual situations. What do you think about that, I mean your experience in doing that? What do you feel?

E: Before I followed the research experiment and did teaching practice, I feel that my students just made a note, saw me in front of the class and it was uncommon for me to use model or media. Then, what I saw in some meetings in the research experiment, I felt that students did not have to make notes and were not forced to see the whiteboard and they were moving. It was suitable with the characteristics of the students with whom we worked, since they always like to move. Beside that, it was good for them to study in a group to use models. But I feel not too satisfied with the condition in the research experiment, since I need to repeat and repeat again and need more time than usual, but I could see the happiness of the students when they learned. I was so surprised and just realized that actually the students have great development of thinking and they could be asked to think further than I expected of them. So there were some questions that enlarge their thinking and I just was a mediator without always giving them the knowledge directly. I just felt it yesterday when I taught using RME's method.

R: Do you find any struggle?

E: Yes, as learner, it is normal to have struggle. In my teaching practice, i feel confuse with connecting the equivalence fraction activity and move to addition fraction. At that time, i posed questions to students while i am also thinking myself.

According to the transcript, Evin show positive response on Realistic Mathematics Education approach and she found the attitude's changes on her students though she needs to do some efforts to make her students understand the concept. Evin also experience stuck with how to connect the lesson from one unit to different unit. She tried to 'buying time' when she faced her stuck. Amar also shared her experience when doing teaching practice. She supposed to be in hurry in delivering the abstract concept within the activity and struggle in the abstraction process from the activity.

### Discussion

If we differentiate the two systems in learning mathematics such as situational mathematics and algorithm/abstract mathematics, those two system are experienced in the RME's teaching approach. As description of evin and Amar's learning process of RME, they experience the divorce on the two systems. They are more challenged in the integrating one mathematics system such as the mathematics situation to another system namely the algorithm of mathematics. It was shown by Evin and Amar when they were directly move to algorithm in the teaching practice after the contextual situation introduced and developed model for mathematizing. They are lacking in interpreting the mathematics algorithm from the developed situation.

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