TEACHING MATHEMATICS IN INDONESIAN PRIMARY SCHOOLS USING REALISTIC MATHEMATICS EDUCATION (RME)-APPROACH

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ABSTRACT

This paper presents a case study about employing Realistic Mathematics Education (RME)-approach to teach mathematics in Indonesian primary schools. Many obstacles, such as the very dependent attitude of the pupils, the pupils who were not used to working in groups, lack of reasoning capability and lack of understanding of basic concepts, were found when the pupils, who were used to the traditional way of teaching, dealt with the new approach (RME). The discussion in this paper is focused on these obstacles and the efforts undertaken to overcome them.

1. Introduction

There is a number of problems in mathematics instruction in Indonesian primary schools. For example, the approach that is used to teach mathematics is very theoretical, and many abstract concepts and formulas are introduced without paying much attention on aspects such as logic, reasoning, and understanding (Karnasih & Soeparno, 1999; Soedjadi, 2000). Besides, the teaching learning-process is always organized in a traditional (teacher centered) way (Somerset, 1997).

The conditions above make mathematics more difficult to learn and understand and pupils become afraid of mathematics. Moreover, the conditions also create unfavorable climate for mathematics instruction in the classrooms. In general, the climate in Indonesian classrooms is similar to those in several African countries as was summarized by de Feiter at all. (1995) and Ottevanger (2001) as follow: pupils are passive through out the lesson; 'chalk and talk' is preferred teaching style; emphasis on factual knowledge; questions require only single words, often provided in chorus; lack of learning questioning; only correct answers are accepted and acted upon; whole-class activities of writing/there is no hands work is carried out.

In our research project (started in 1998 and is partly reported in this paper) we explored the extent to which Realistic Mathematics Education (RME) could address some of the problems in mathematics education in Indonesia, more specifically in the geometry instruction. This aim is realized by developing and implementing the student book and teacher guide based on RME theory through development research (see Akker & Plomp, 1993; Richey & Nelson, 1996).

The paper reports about the very first experiences in Indonesia to teach geometry according to the RME approach, and addresses specifically the research question '*what are the obstacles when introducing the RME approach and how can they be overcome*?' In the next section, the characteristics of RME will be summarized. Then, the RME-based intervention for teaching geometry topics to grade 4 classroom will be described followed by the design of this research. The report of the research findings is followed by some conclusions and reflections relevant for further work in this area.

2. Realistic Mathematics Education (RME)

RME is an approach in which mathematics education is conceived as human activity (see Freudenthal, 1973; Treffers, 1987; Gravemeijer, 1994; De Lange, 1987, 1998). In RME, learning mathematics means doing mathematics, of which solving every day life problems (contextual problems) is an essential part.

There are three key principles of RME for instructional design namely *guided reinvention* and *progressive mathematizing, didactical phenomenology,* and *self developed models* (Gravemeijer, 1994). Even for teaching learning process, RME has five learning and teaching principles: *constructing* and *concretizing*, *level* and *models*, *reflection* and *special assignment*, *social context* and *interaction*, *structuring* and *interweaving* (see De Lange, 1987; Streeflands, 1991; Gravemeijer, 1994). So, in RME-based lessons, pupils should be given the opportunity to reinvent mathematical concepts, and teaching learning process would be highly interactive. The main role of teachers is to determine in which way an optimal result can be obtained, for example by organizing pupils' interaction, individual work, group work, classroom discussion, pupil presentation, teacher presentation, and/or other activities.

Given its characteristics, RME is considered a very promising approach to change the classroom' climate in order to improve mathematics teaching and make it more relevant for pupils in Indonesia.

The Intervention: a series of lessons on topic '*area and perimeter*'

To investigate whether and under what conditions RME can be utilized in Indonesian primary schools, a series of 10 lessons have been designed for pupils at grade 4 (age 9 – 11) on the topic 'area and perimeter'. There are two potentials of RME-based lessons on this topic compare to traditional lessons. Firstly, Indonesian curriculum for topic area and perimeter school contains only the most minimal concept of area that is area as "length times width' or area as counting the squares centimeters in a rectangle or square. Even in the RME-based lessons the concept of area is broaden to other shapes, by relating area to other "magnitudes' (costs, weight, paint, rice, cake, etc.); investigating the relation between area and perimeter; connecting measurement units to reality; integrating some geometry activity (re-shaping, tessellation, etc.). Secondly, the lessons for topic area and perimeter in Indonesian curriculum emphasize only on applying the formulas (after the formulas are introduced deductively using chalk and talk method). In other hand, RME-based lessons would create the situations that due to learning and teaching principles and RME characteristics mentioned above such as pupils centered instruction, pupils active learning (interactivity), pupils free production (reinvention and self-developed models), etc. The principle 'free production' would stimulate pupils' reasoning because the pupils have to share or discuss concepts they reinvent or models they develop in solving contextual problems.

Related to the potentials of RME-based lessons, pupils are expected not only to master the mathematical concepts related but also to pay much attention on the process related. They are expected to know how to work in groups, be active and creative in reinventing the concepts related and developing their model in solving a contextual problem, understand the importance of giving an explanation for a solution. The same case for teachers, they are expected to be able to attract the pupils to solve the contextual problems, stimulate the pupils when they are working in groups, to react upon the pupils' contribution, and to guide the classroom discussions.

As there was no information at all about how Indonesian pupils would react on such a new approach, it was decided to use an '*emergent*' design approach: the series of lessons was only planned in general terms of what content, methods and learner activities should be applied in the lesson series, while the detailed plan for each lesson would be strongly determined by the events and experiences of the preceding lesson(s). This approach implies that only the first lesson a detailed plan was designed.

3. Design of the research

Given the research question and its context, the research reported here has an exploratory character. The research was conducted in a primary school in Surabaya (East Java). As no teacher in Indonesia has experience with teaching RME-based lessons the first author taught the pupils himself, even the teacher and the second author taking the role of observers. The data collection focused on pupils' activities and reactions when they dealt with RME-approach. The instruments used to collect the data were observation scheme, logbook, and interview guidelines. The data analysis in this exploratory research was qualitative and judgmental

4. Research Findings

Below is described what happened in the consecutive lessons to the classroom . The data are presented in narrative form to be able to convey the richness of the interactions and other processes that took place. As the first author acted as the teacher, researcher (formative evaluator) and developer of the lessons, this part of the paper is written in a 'personalistic style'

Finding from lesson 1

The topic for the first lesson is "the sizes of shapes" in which pupils would compare and order the sizes of various shapes. To do these activities, I prepared materials such as: worksheet, tracing papers, drawing papers, and scissors. An important goal of the lesson is to see how pupils would react and act to the change in roles: from passive listening and making exercises towards active working on mathematics tasks. In this meeting pupils worked in groups of 4, in which pupils who sat next to each other were in the same group. The pupils were grouped to make it easier to observe their activities. At the beginning I explained what the lesson is about, what expectations I had from the lesson (the changes of pupils' and teacher's role, compare to traditional method), what activities the pupils would do, and what the nature of the materials was which I provided for. This was what happened when the pupils dealt with the first contextual problem.

Hand Size-fingers

Draw the outlines of your hand size-fingers on a piece of paper then find out who has the smallest hand size-fingers? Explain your answer!

After reading the contextual problem the pupils kept silent. It seemed they did not know what to do and were waiting for instruction. I tried to explain and encouraged them to use any materials in order to solve the problem, but there was none of the pupils started to work. Because of that, I explained how to draw hand size-fingers on a drawing paper/tracing paper. Then, I gave a clue how to use those drawings to find the member of groups who had the smallest hand size-fingers (by putting one drawing on top of the others). Some groups were not interested and just observed their drawings then decided about the answers (without giving any reasoning). When I asked them `how do you know it is the smallest?', they just looked at each other. Because most pupils were still confuse, I asked them to cut out their drawings in order to make easier to compare the drawings. All groups did this but only two groups (out of ten) succeeded on this task.

Initially I thought the problem was because of poor reading ability. After asking some pupils I discovered that the problem was not in reading but that the pupils never worked on story problems. Besides, they were used to a situation in which the teacher would give first an example, after which the pupils do the tasks that similar to the example.

Working in groups was not running smoothly because only one or two pupils in each group were working seriously, while the others were waiting for the answers. Moreover, the pupils in the mixed groups (boys and girls) did not enjoy working together.

From the first lesson, the following points emerged as lessons learned:

- Most pupils had a very dependent attitude. They lacked initiative very much, and were not self-confident in solving a problem. Every time after they finished a task, they always asked me (the teacher) to come closer and check if what they did were correct or not.
- I had difficulties in organizing the class because the pupils shouting many times asking for helps. The classroom was also too small so that I could not move easily from one group to the others to give guidance.

- In solving a contextual problem, the pupils could not explain about what they did, how they did it, or why they did it, neither orally nor in written.
- The problem in the mixed groups (boys and girls) was because of the pupils' culture. In their everyday life, it is rarely seen that boys and girls are doing activities together. So they were shy to work together in one group.

Finding from lesson 2

The tasks in lesson 2 were similar to those in the lesson 1. Dealing with the problems found before, I made a plan for this lesson as follow:

- using Overhead Projector (OHP) to attract the pupils and to focus their attention to the process of solving the contextual problems;
- minimize the intervention of the teacher in order to reduce dependent attitude of the pupils;
- making agreements on not shouting, putting a hand in the air when wanting to say something.
- in grouping the pupils, they could choose their friends themselves.

However, this planning did not go well. It was the first time the pupils followed an instruction using OHP. Some pupils came closer to see the OHP and played with its light, and the others were laughing when seeing the shadows were moving on the screen. Pupils from other grades (they did not have lessons at that time) were also curious, especially about the use of OHP and presence of the observers in the classroom. They stood in front of the door and made noise.

Most pupils still asked 'what should they do now and next?'. I tried to motivate them to think themselves by giving hints and/or rising stimulating questions. This effort worked for most of the pupils, but still did not work for some pupils who were very weak in basic mathematical concepts. (they could not draw a simple geometry objects; they also still used their fingers to count 3 x 4, and did not know the results of 8 x 7, a half of 6, a half of 9, etc.). These pupils really needed guidance step by step in solving a problem.

The frequency of pupils' shouting in asking for helps and clues was reduced, although sometimes they forgot the rule. The motivation of most pupils to work in groups was increased, and they also started to give the reasons for their solutions orally as well as in writing, although most of those reasons were not relevant to the questions. It was also found pupils' tendency just to get the results and did not pay attention to the process in solving a problem. For example, some groups preferred dividing the tasks among the group members in order to get the answers as soon as possible, rather than having a discussion to find the answers together.

The findings mentioned above can be seen as the effects of the traditional way of teaching as these pupils were almost never work on contextual problems and the teacher never conducted working group. As a consequence, the activity and creativity of the pupils were not developed well because lack of opportunities.

I learned from the two lessons that the pupils needed time to get used to the new approach (RME), therefore some more efforts had to be done to realize it. Below is summarized the efforts were done in the next lessons (3 –10) and the impacts that these had.

Lesson 3-7: the efforts and impacts

Firstly, the effort related to the condition where the pupils were not used to the contextual problems. In the third meeting I read the contextual problems for the pupils orally, instead of just let them read and solve the contextual problems by themselves. Sometimes I changed the context (became not exactly the same with those in their book) to make the problems more interesting so that the pupils could come inside the problem and then they feel responsible or have motivation to solve them. After reading a contextual problem, I took some times to rise questions; for example: *Who can explain what the problem is about? Who get an idea to solve the problem? Who has*

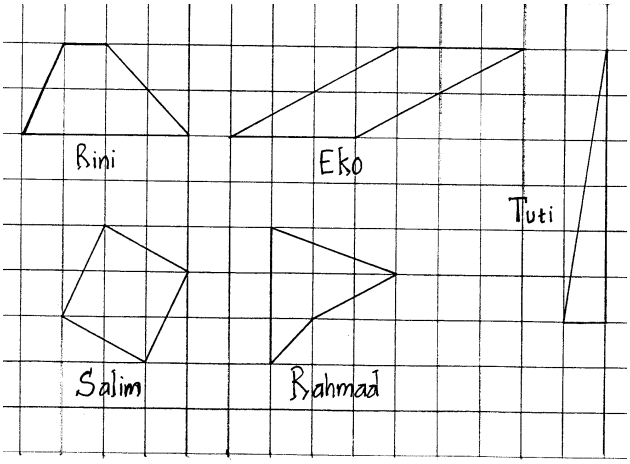
another idea? This tactic could work well. The pupils started to give their contribution in solving a problem, though their opinions were frequently not relevant. But by emerging democratic condition (not just saying right or wrong for what the pupils said) in the classroom, the pupils were not afraid anymore to mention their idea.

The positive impact of this effort was found in the fourth meeting. In this meeting the pupils worked in groups of 4 with special assignment in which a member in a group should write down the answers on the blackboard. I observed that most pupils were very enthusiast in doing this task. Each group had a discussion to find the answers instead of dividing the tasks among the group members (as they did before). They were glad when they finished one task then could show the result on the blackboard directly (the groups competed each other).

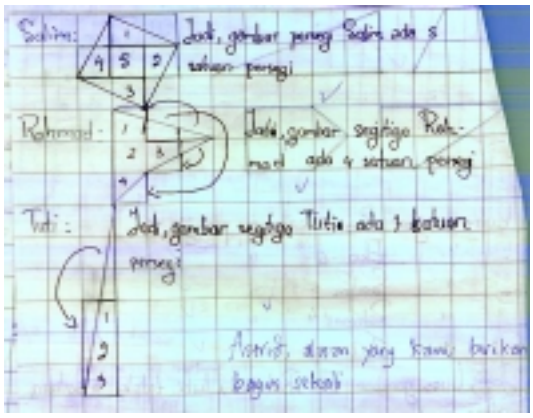
Secondly, the effort related to pupils' tendency just to get the results and did not pay attention to the process. I succeeded to stimulate them in changing that attitude after applying some rules in the class. I told the pupils that they would not get a maximum mark if they could not show or explain the process and reasons in solving a problem. Moreover, I also wrote the notes in pupils' exercise books, asking them to explain the processes and reasons every time they worked on their homework. This effort had an impact in that the pupils started to give explanations or reasons. Even at the beginning most of their reasoning was very weak, but after few meetings most pupils showed an improvement. The next example shows an improvement of a pupil (Astrid).

In the first two meetings, Astrid was very weak in reasoning. Every time she compared "the size of shapes" she wrote '*…… is bigger than……, because it is looked bigger* or *when I measure it, it is bigger'*. In the third meeting she wrote *'when I compare it, and tried to trace it, I found……'* eight times in solving the problems. However, in the seventh meeting she could come with nice idea when she worked on the problem below.

> *Rini, Eko, Tuti Salim and Rahmad drew the shapes below. Did they draw shapes with area five square units? Explain your answers.*



She used reallotment strategy to explain her answer on this problem:

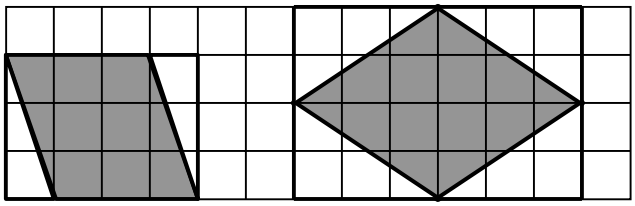


Astrid found that the drawing of Salim was 5 units square, Rahmad was 4 units square units, and Tuti was 3 units square using reallotment strategy.

Attitudes of the pupils and parents

There were also found interesting facts related to pupils' and parents' attitude. Firstly, in checking the solutions of the exercises or homework, the pupils preferred to do it classically so that they could express their happiness (by shouting) if their answers were correct. They also asked me to put the mark on their exercise book every time they finished an exercise or homework. This was not only for the proud of the pupils themselves (especially when they get 10) but also because the parents always ask the marks the children get every time they back home from the school.

Secondly, some parents helped their children doing the homework. But the main reason for this was only to increase the mark of the pupils (the marks for the homework used to be considered in determining the final mark). They did not pay attention on pupils' understanding, because when I asked the pupils about what their parents told them they could not explain. The next is an example of what the parents taught their children.



To determine the areas of shaded figures above, the parents told the children to use the formulas of parallelogram (for the figure on the left) and kite (for the figure on the right). It seemed that the parents only think about topic 'area' as merely playing with the formulas (at this moment the pupils have not learned the formulas yet). In fact, the problems could solve easily using reallotment strategy or by halving (without knowing the formulas).

5. Conclusion

There were many obstacles in applying RME in Indonesian mathematics education. Nevertheless, this first pilot with RME had many positive impacts on the teaching-learning process in the classrooms. The difference in the learning behavior of the pupils found from day to day showed that RME is a potential approach for teaching and learning mathematics. Based on the interviews with a number of pupils it was know that they like the new approach. They realized that there were some positive changes on themselves especially in reasoning, activity and creativity. The teacher himself admitted that there were positive changes on the pupils' behavior after they dealt with RME-based lessons.

In conclusion, RME is an approach to mathematics education developed in the Netherlands, but the exploratory research reported here shows that this approach is not something impossible to utilize in Indonesia. But to realize this, a big effort is needed in the areas of curriculum development, assessment practices, and teacher (in-service) training, all supported by focused development research and formative evaluation to assure that 'local' relevancy will be obtained. The efforts needed should not be underestimated as the change touches on the roots of mathematics education in Indonesia: it is necessary that all stakeholders understand that not only a new curriculum and a new pedagogy is needed, but above all that the notion of what is good mathematics education has to change (see Fullan, 1991). Therefore, a process of changing to the mathematics curriculum and culture towards introducing RME in Indonesia is only possible with the support of the government. The government has to play an important role, in the first place by providing the budget that is needed to facilitate the research and development in all three areas mentioned above. But also in order to develop a policy on mathematics education that provides the formal and 'administrative' support that such a change of the national curriculum and assessment approach needs. Moreover, the teacher training institutes may become the first "targets' for change, as they have to play a central role in preparing the teachers to be capable of teaching and disseminating RME.

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