PROFESIONAL DEVELOPMENT OF MATHEMATICS PRIMARY SCHOOL TEACHERS IN INDONESIA USING LESSON STUDY AND REALISTIC MATHEMATICS EDUCATION APPROACH

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Abstract

Since ten years the implementation of Indonesian version of Realistic Mathematics Education (RME), labelled as PMRI (Pendidikan Matematika Realistik Indonesia) in Indonesia, many programs have been done in order to improve mathematics teacher effectiveness. This paper aims to discuss how can lesson study and PMRI approach are used in a professional development program for improving the performance of the primary school mathematics teachers. In order to conduct the program, action research method is used. This research conducted in four PMRI pilot schools and field tested to 30 primary teachers in Palembang, Indonesia. They followed and got involved in three steps of lesson study namely plan, do, see. First, the teachers worked in four different working groups. On each group, they developed learning materials that they used in the schools. Then, they implemented the learning materials to the students in the classroom. In each group, a teacher performed as a model while the others as observers. Furthermore, after they finished their activities in the classroom, they discussed and reflected what they have done. Data were collected using observation, documentation, questioner, and photos. These data will be presented during presentation in the conference. Results show that the program able to improve the performance of mathematics primary school teachers in developing lesson materials on PMRI and implementing the materials in the classroom. Implications for practice, the program can be used for improving the performance of primary mathematics teachers in schools, either PMRI pilot or new schools, in other disctricts or provinces in Indonesia.

Keywords: Profesional Development, PMRI, Realistic Mathematics Education, Lesson study, Action research, Primary school teacher,

Introduction

PMRI is an innovation in mathematics education in Indonesia. It was initiated by group of teacher educators and mathematicians in year 2001 (Sembiring, Hoogland, & van den Hoeven, 2009). It is a new way of teaching and learning aiming at better results for the students. The movement is supported by Directorate General of High Education (DGHE). It is now a growing movement and shows promising results (Sembiring, Hoogland, & Dolk, 2010).

Lesson study is a form of long-term teacher professional learning in which teachers systematically and collaboratively conduct research on teaching and learning in classroom in order to enrich students learning experiences and improve their own teaching (Stigler & Hiebert, 1999). The lesson study is started in three Teacher Education Universities and schools in 2002. The efforts of improvement have been done to educational output intensively, but the packages of education are not in line with the nature of teaching and learning. In the other word, educational reform that was going in Indonesia is not already completed to pay attention to teaching and learning concept. Educational reform should be started from how students and teachers learn and how teachers teach, not merely to the learning result. This paper will describe developmental practice of teachers of primary school by lesson study.

The purpose of this paper is to discuss how can lesson study and PMRI approach are used in a professional development program for improving the performance of the primary school mathematics teachers.

Theoretical Framework

Lesson Study

Lesson study is a cycle of activities in which teacher design, implement, and improve one or more research lessons and make positive changes in instructional practice and student learning (Stigler & Hiebert, 1999)

Japanesse experts indicate that Lesson study is considered as: 1. intiative of a group of teachers to improve themselves in teaching, and to get any input to make innovation based on the result of good plan and implementation (open for other teachers/observers to visit their class); 2. medium for learning of teacher or other participant including the teacher as presenter; 3. medium for discussion or sharing experience to improve teaching quality. Meanwhile, we define Lesson Study as an activity carried out by a number of teachers of a certain subject in collaboration with educational experts to improve the quality and content of their teaching. Lesson Study has three (step) main activities: planning, implementing (teaching & observing), and reflecting and revising.

1. Planning

During the lesson study planning phase, the participants first identified the problems found in the classroom. The identification of the problem accompanied by the solution taken are related to the teaching material, schedule, students' characteris tic, class condition, teaching method, teaching media, experiment kits, and evaluation toward the teaching process and result.

They discussed the choice of teaching material, method, and media based on students' characteristic and evaluations to be used. There are suggestions/input from teachers and content experts. Experts or senior teachers would give opinion about new things to be applied by teachers in the classroom, including using the teaching approach of constructivism, contextual teaching and learning, life skill, realistic mathematics education, or using the newest teaching material.

Additional discussion focused on the collection of data on the observation sheet, especially about determining the indicator of good teaching- learning process seen from the aspect of teacher and students. Those indicators were written based on the lesson plan and approaches used to reach out to students during the teaching- learning process.

Based on the identification and solution of the problems above, it was carried out into a set of steps consisting of:

a. Lesson Plan
b. Teaching Guide
c. Student's worksheet
d. Teaching media
e. Evaluation sheet of teaching process and result
f. Observation sheet

The lesson plan can be written by one or more teacher who agreed with the aspects of the planned teaching. To increaese the effectiveness of the lesson, the result is then discussed
with other teachers and experts of their group.

2. Implementation and observation

In this phase, a teacher implemented the lesson plan while other teachers and expert observed the process using the prepared observation sheet. To support it, the observer videotaped the lesson.

3. Reflection

In this phase, the teacher who implemented the lesson plan was given time to state his feeling during the implementation both for himself and his students. Next, time was given to observers, both expert and other teachers, to share the data they collected on the students' activity during the implementation followed by showing of the video. The teacher of presentation, then, wa s asked to respond the observers' comments. The important thing in reflection is to reconsider the lesson plan developed as the basis to make improvements for the next teaching.

PMRI

PMRI, an approach that is adapted from RME, is determined by Freudenthal's opinion about mathematics. Two important opinions from him that *mathematics must be connected to reality and mathematics as human activity*. First, mathematics should be closed to students and relevant in students' daily life. Second, he stressed to mathematics

as a human activity, so that students should be given a chance to do learning activity in all topics in mathematics (Ilma, 2006).

Three Principles of PMRI

1. *Guided reinvention and didactical phenomenology*

Because mathematics in RME theory is a human activity, so guided reinvention can be described that teacher should give students a chance to understand and do mathematics process by theirselves when mathematics was found. This principal can be inspired by using procedure informally. This effort will be reached if teaching and learning processes use real context in daily life which are related to mathematics concept.

2. *Progressive mathematization*

The situation that contained with phenomenon that can be used for material and application area in teaching and learning mathematics should be started from real situation before get to the top (formal mathematics). Two kinds of mathematization should be used as references in teaching and learning mathematics from concrete to abstract (formal).

3. *Self-developed models*

The role of self-developed models is as a bridge for students from concrete to abstract or informal to formal. It means that students can make their own model to solve problem. The problem is started with the situation that closed to the students' daily life. From generalization and formalization, the model will be changed into *model-of*. Then, *Model-of* will be shifted to *model-for* in the sane problem.

Characteristics of PMRI

From three principals of PMRI above, there are five characteristics of RME that related to teaching and learning model – material (the first, second, and the fifth of charasteristics), method (the fourth of characteristics), and assesment (the third of characteristics):

(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.*

Designing Teaching and Learning Process Based on PMRI

Goals. Goals should includes three level of goals in realistic mathematics education: lower level, middle level, and higher order level. The last two of goals stress to the ability of argumentation, communication, and the formation of critical attitude.

Materials. The design of an 'opening material' which is connected in the reality departs from the meaning context; in need; interconnection among lesson lines of the unit or other originally real topics such as fractions and percentages; and models or pictures used as tools, diagrams and situation or symbols generated during the learning process.

Activity. Teachers should organize student activities so that they can interact, discuss, negotiate, and collaborate with each other. In this situation they have the opportunity to work, to think and to communicate about mathematics. The role of teachers is only as the facilitator or preceptor.

Evaluation. Evaluation materials must be made in the form of 'open question' which provokes the students to answer freely and uses various strategies, various answers or free productions. The evaluation should include formative and summative question (Zulkardi, 2002; Ilma, 2009).

The following picture is how all RME characteristics are represented in the model of learning.

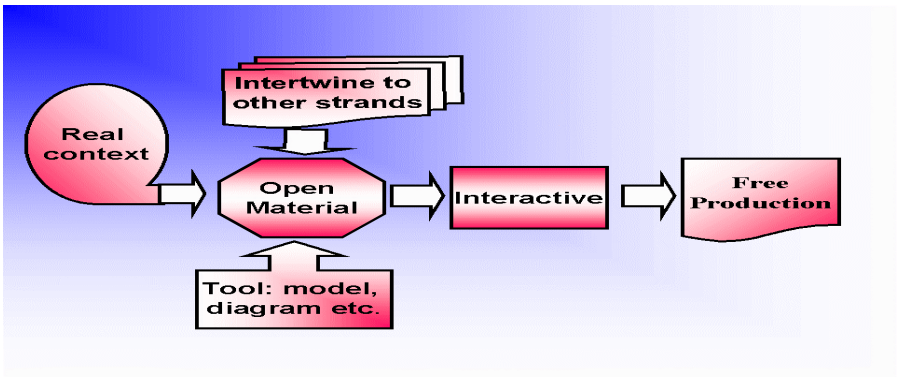

Figure 1. *Model for designing mathematical learning model based on the RME approach. (Zulkardi,2002)*

Realistic Mathematics Education (RME) (Gravemeijer, 1994, 2010) is a domain specific instructional theory, which offers guidelines for instruction that aims at supporting students in constructing, or reinventing mathematics in problem-centered interactive instruction.

Research Methodology

The method that is used in this paper is action research. This research was conducted in four primary schools which are PMRI pilot schools in Palembang, Indonesia. The program was followed by 30 mathematics teachers which got involved in three steps of lesson study that is design, implementation and reflection. First, the teachers worked in four different working groups. On each group, they developed research lesson or learning materials. Then, they implemented the learning materials to the students in the classroom. In each group, a teacher performed as a model while the others as observers. Furthermore, after they finished their activities in the classroom, they discussed and reflected what they have done.

a. Design of Research

This research used design of classroom action research that is planned into some of cycles which each of cycles consist of 4 stages of activity, namely (a) planning, (b) doing action, (c) observing, and (d) evaluating and reflecting.

1. Planning

   In this stage, the action plan is arranged to improve activity and achievement of students.

2. Doing action
   The activity in this stage is applying learning scenario based on the action plan.

3. Observing

   Observing in this stage was done by using observation sheet and evaluation tools to process and output of research action.

4. Data analyzing and reflecting
   Data analyzing and reflecting was aimed to know how far of action that has applied to achieve the learning objective. If doing action in the first cycle does not exhibit result that should be, then the researchers and teachers have to do reflection in order to revise the plan of action for the next cycle.

b. Procedure of research

This research used design of classroom action research in which procedure of research develops cycles repeatedly. Many of cycles based on research objectives. The detail of procedure (flowchart) illustrated in figure 2 below.

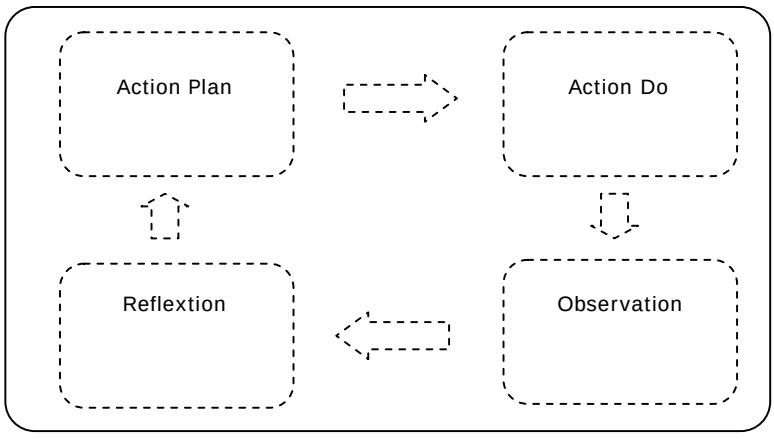

Figure 2. flowchart of PTK

c. Data sources or evidence

Data were collected using observation (activities of student and teacher model) and documentation (student's solution or contributions), field note and video-recording (classroom situation). These data will be presented during presentation in the conference.

d. Results and discussion

Activities of professional development started from training at Graduate Program Unsri as long as 3 days for teachers of primary school by using Lesson Study in which teachers entirely provide learning equipment, then they demonstrated in front of the participant. Next, they reflected learning that has demonstrated in the training conducted to 30 people of mathematics teachers, then becoming PMRI teachers.

Figure 3. Teacher are constructing material

Figure 3 show that each of groups consists of 5 people are constructing learning equipment that they will design and demonstrate.

Figure 4. Teachers demonstrate their equipment in front of the participant

In the figure 4, you know that teachers demonstrated their design of learning equipment, lesson started by showing GOR Jakabaring picture. This picture showed many people were watching football match. The capacity of GOR that can be loaded watchers is the problem that asked to the participant assumed as students to estimate. It is the first context to introduce students by hundreds-thousands value. The next context is "shopping in the market". Indirectly, students do counting in this context.

On August, 4th 2010, teachers of PMRI tried out their learning equipment that was provided to grade four at MIN 2 Palembang.

Figure 5. While learning process in grade four at MIN 2 Palembang

In the figure 5, place values as material given by the teacher, as starting point teacher introduced students by using colored sticks of ice cream. In this case, teacher used the red one as hundreds-thousands value, the yellow one as tens-thousands value, the green one as thousands value, the blue one as hundreds, the silver one as tens, and the purple one as ones. The value of colors of sticks is flexible place that can be turned. Teacher can rearrange the order of color as place value.

By using these sticks, students know that 10 sticks of the blue one can be replaced by one stick of the green one (one thousand). It means that 10 sticks of the blue one are equal to 1 stick of the green one or 10 houndreds = 1 thousand. Teacher guided students to mention other place value by using the sticks. For instance, number 27.635 by using sticks, such as 2 yellow colored sticks, 7 green colored sticks, 6 blue colored sticks, 3 silver colored sticks, and 5 purple colored sticks. Teacher also asked challenging questions to students by problems which any 0 in the middle of the number, such as 704.503, 340.200 or 60. 890. Teacher guided student's to reinvent by theirself how to write symbol of 0 that is in the middle of numbers. In line with PMRI, we called guided reinvention.

For the last activity, there are 6 indicators that we observe as long as learning activity. All indicators are 100% in category of yes, it means that all of indicators that can be found in the learning process are (1) teacher conclude the lesson based on participant's contribution after discussion, (2) teacher evaluate participants by using application and intertwining problems in the last unit to improve participants about mathematical concepts that they have learnt, (3) some of student's concluded from the lesson during the time, (4) teacher guide participant's conclusions, (5) every student made final assessment that contain concluding problems or problems related with concept of conclusion, and (6) all of student's collected their work immediately after teacher gave instruction.

Some factors aren't allowed in the last lesson, the result of observation show that all of indicators in category of no. These indicators are: (1) teacher conclude the lesson based on their own argument, (2) teacher don't give the last assessment or homework, (3)

more than one third of total of student's are unconcentrated while they learn (not take care), and (4) teacher wasn't using available time of learning efficiently.

Table 1. Observation Result of teacher who teach in grade four MIN 2 Palembang

No.	Activity	Yes	No
1.	Opening	90 %	10 %
	The factor is not allowed in the opening	0 %	100 %
2.	Activity while learning	94,2 %	5,8 %
	The factor is not allowed while learning	0 %	100 %
3.	Last activity	83,3 %	16,7 %
	The factor is not allowed in the last activity	25 %	75 %

According to table 1 above, 90% of indicators of teacher's assessment in the opening is satisfied and 10% of indicators is not satisfied. Indicator that is not emerge in the opening was teacher is not giving instruction yet to students how to use available time. One of indicators can not be assessed, that is reviewing homework because in the last meeting teacher was not giving homework to students. the indicators that not allowed in the opening are not appeared. Teacher was ready to introduce context very well, and not give negative respond to the student's answer.

While learning process, 94,2% of indicators in observation sheet is satisfied very well. 5,8% of Indicators is not satisfied, that is teacher made group based on the rule. Students are not making group by theirself. This possibility caused by grader one who are difficult to determine group by theirself, and finally they are grouped with near friends to them. The factors that not allowed while learning process can be escaped by teacher. By percentage as much as 100%, it means that teacher was not showing the factors that not allowed while learning process.

In the last minute of learning, 83,3% of indicators in the observation sheet is satisfied very well and 16,7% of indicators is not already satisfied. It means that only one point is not already satisfied, that is teacher was not already evaluating students in the last unit by using application and intertwining problems to improve participants' knowledge about their new concept. The rest of time to learn mathematics that is limited is one possibility, therefore teacher looked to end the lesson in rush. One thing that teacher forgot is teacher didn't give the last assessment or homework. Giving task based on PMR is needed to expand students' ability of understanding learning material more than tasks from the teacher when they learnt in the classroom.

Figure 6. Reflecting learning process

In the figure 6, some experts and all of teachers reflected learning process. In this session, participants gave comments and suggestions about learning process.

Results show that the professional development program is able to improve the performance of mathematics primary school teachers in developing lesson materials on PMRI and implementing the materials in the classroom. Also the performance of students in terms of learning activity is improved.

Educational importance of this study

The importance of this study can be used for improving the performance of primary mathematics teachers in schools especially in designing and implementing lesson materials. Furthermore, this study enriched and improved the students' learning experiences. Besides that, by this activity we have trained 30 primary teachers about PMRI in Palembang.

Suggestions

a. For the teachers have been trained, we hope they continue to socialize PMRI for the other mathematics teachers who want to learn about PMRI.
b. Expectation for the future, learning environment of PMRI can be the place of certification for mathematics teacher who want to learn PMRI and to be PMRI teacher.
c. Learning model of various mathematical topics is needed to be used not only for the students but also the teachers such that the next research will be applied in other regencies of South Sumatera.

References

Graveimeijer, K. (1994). *Developing Realistic Mathematics Education.* Utrecht: CDBeta Press.

Graveimeijer, K. (2010). Realistic Mathematics Education Theory as a Guideline for Problem-Centered, Interactive Mathematics Education. In Sembiring, R.K., Hoogland, K., & Dolk M. (2010). *A Decade of PMRI in Indonesia*. ISBN 90-6607-384-5. Utrecht: APS International.

Ilma, 2006. Mendesain Sendiri Soal Kontekstual Matematika. *Prosiding KNM XIII*, hal 403-409. Universitas Negeri Semarang.

Ilma, 2009. Peningkatan Kemampuan Mengajar Matematika menggunakan PMRI di Sekolah Ujicoba PMRI di Palembang. dalam Zulkardi (Ed.). *Prosiding KNM XIV*, hal 919-927.Unsri.

Sembiring, R.K., Hoogland, K., & van den Hoeven, G. (2009). *Initiation, Implementation and Institutionalization of RME in Indonesia*. Paper presented at the ICSEI 2009: The 22nd annual meeting of the International Congress for School Effectiveness and Improvement.

Sembiring, R.K., Hoogland, K., & Dolk M. (2010). *A Decade of PMRI in Indonesia.* ISBN 90-6607-384-5. Utrecht: APS International.

Stigler, J.W, & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in classroom*. New York: Summit Books.

Zulkardi, 2002. *Developing a Learning Environment on Realistic Mathematics Education for Indonesian student teachers*. Disertation. Enschede: University of Twente