

Re-conceptualizing Good Practice of Mathematics Teaching Through Lesson Study in Indonesia

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Abstract: *Currently picture of Indonesian educational practices changes very fast at all level of dimensions; it offers the hopes and the challenges to re-conceptualize good practice of teaching. The implementation of the new Curriculum (Curriculum 2013) can be the starting point for mathematics teachers to reflect and move their old paradigms of teaching; due it offers flexible and various approaches of teaching. It encourages the teachers to evaluate the strengths and weaknesses of different approaches in order to make informed choices and, when necessary, should be prepared to learn new skills in the interests of effective teaching learning mathematics. Through this new curriculum, the mathematics teachers need to be able to respond to individual children as it is identified because the relevant curricular experiences and skills of children vary greatly and they need then in a better position to draw upon support services to enhance their classroom practice. The management of the range of support services should be available to maximize their effect in helping teachers to work towards good practices and to implement new curriculum. Lesson Study activities provide the schema for the teachers to promote good practice of mathematics teaching. It also gives the chance to the government officials of education in Indonesia to look in-depth the implementation of curriculum in the class-room level. However, re-conceptualizing good practice of teaching does not only emerge amidst the reflection and monitoring of the new curriculum as the new schema to operate education; but also at any chance of initiating education improvement in which Lesson Study program can be implemented.*

Introduction

Mixing from value beliefs and empirical evidences, there are currently demands in Indonesia, that any educational reform should handle the issues of: (a) how to promote interactive curriculum rather than instrumental curriculum, (b) how to promote student centered approach rather than teacher centered approach, (c) how to promote students' initiation rather than teacher's domination, and (d) how to promote simple and flexible curriculum rather than crowded and tight-structured curriculum. While in term of observable good practice, there were demands that teachers need to have a chance to reflect their teaching in such a way that they may move from older paradigm of teaching to the new one. Teachers may move from emphasizing the "teaching" to emphasizing the "learning"; they may move from the act of "transferring teacher's knowledge" to "constructing students' knowledge".

The Decree of Sisdiknas No. 20 year 2003, Indonesian Educational System should develop intelligence and skills of individuals, promote good conduct, patriotism, and social responsibility, should foster positive attitudes of self reliance and development. Improving the quality of teaching is one of the most important tasks in raising the standard of education in Indonesia. The programs which have been carried out to improve the quality of teaching are the improvement of the quality of teachers; the provision of learning facilities and equipment; the improvement of the curricula for basic education; and the development and utilization of communication technology for education in supporting the teaching learning process. The improvement of the quality of teaching, thus, has become one of the fundamental issues in the improvement of the quality of education in Indonesia. The quality of teaching learning process is closely related to what the students do in classroom.

Indonesian Central Government, in 2013 and 2014 has launched some Ministerial Decrees as the bases for implementation of the new curriculum for primary and secondary education, called as Curriculum 2013. This new curriculum combines two paradigms in which, one side stresses on students competencies while the other side, concerns students' learning processes. From the stated curriculum, it can be learned that teaching learning mathematics involves the teaching of many different areas of knowledge, and of many skills. When new knowledge or skills are required for problem solving, the students need to develop their mathematical attitude. Katagiri, S. (2004) suggests that, to develop mathematical attitude, students need to realize which previously learned, to sense "the necessity of" and perceive the need or desirability of using new knowledge and skills.

The currently studies (Marsigit, 2010) on mathematics education in Indonesia have the indication that children's achievement in the subjects of mathematics and Science is low, as indicated by the result of the National Leaving Examination year by year both in Primary and Secondary School. Children's mastery on mathematics concepts and mathematics process skills is still low. This fact may be as the results of: (1) the shortage of laboratory activities; (2) lack of teachers having mastered science process skill approach; (3) contents on Mathematics and Science curriculum too crowded; (4) too many time consuming administration stipulation for teachers; (5) lack of laboratory equipment and laboratory human resource. The study also indicates that mismatch among the objectives education, curriculum, and evaluation system which can be identified by the following: (1) National Leaving Examination assess the children's ability cognitively only; (2) Streaming in Senior Secondary School starting at grade 3; it is argued that the implementation of this system is late and consider individual differences inappropriately; (3) University Entrance Examination System is considered to trigger Elementary and Secondary School teachers apply goal oriented rather than process oriented in teaching Mathematics and Science, (4) many teachers still have difficulty in elaborating the syllabus, (5) a number of mathematics topics are considered to be difficult for teachers to teach; (6) a significant number of children consider some mathematics topics as difficult to understand, (7) teachers consider that they still need guidelines for conducting teaching process by using science process skills approach.

In Curriculum 2013, it was stated that mathematics in primary and secondary school should encourage the students to think logically, analytically, systematically, critically, creatively and be able to collaborate with others. The implementations of primary and secondary mathematics curriculum in class-rooms need to develop problem solving skills covering both closed and open problems. In solving the problems, students need to creatively develop many ways and alternatives, to develop mathematical models, and to estimate the results. Contextual and realistic approaches are recommended to be developed by the teachers to encourage mathematical thinking in primary schools. With these approaches, there is a hope that the students step-by-step learn and master mathematics enthusiastically. To make their teaching learning of primary mathematics more effective, teachers also need to develop resources such as information technology, teaching aids and other media.

The curriculum outlines the aims of teaching learning of mathematics are as follows: (1) to understand the concepts of mathematics, to explain the relationships among them and to apply them to solve the problems accurately and efficiently, (2) to develop thinking skills to learn patterns and characteristics of mathematics, to manipulate them in order to generalize, to proof and to explain ideas and mathematics propositions, (3) to develop problems solving skills which covers understanding the problems, outlining mathematical models, solving them and estimating the outcomes, (3) to communicate mathematics ideas using symbols, tables, diagrams and other media,

and (4) to develop appreciations of the uses of mathematics in daily lives, curiosity, consideration, and willingness to learn mathematics as well as tough and self-confidence.

Good Practice of Mathematics Teaching Through Lesson Study Activities

Re-conceptualizing good practice of teaching and learning of mathematics covers the philosophical and psychological grounds of mathematics, school mathematics, teachers' styles of teaching and students' learning. The mathematics teachers should make clear about the existing trend of theory and paradigm behind their teaching activities. Marsigit and Rosnawati (2014) stated that in whatever the approach of teaching, the teachers need to develop the scheme for achieving students' competencies in such a way that it is reflected in the preparation and implementation of teaching. Teaching learning process can be perceived as various activities or interaction in which the teachers strive to facilitate their students to perform their competencies in mathematics i.e. the students need to construct their own mathematical concepts. Lesson Plan should be developed to guarantee that in the class teaching there will be an appropriate students' apperception, various scheme of students' activities supported by various media and or teaching aids, small group discussions, students' presentation, and students' conclusions. Students Works Sheet has its role to facilitate the students to perform their activities and gradually to find the characteristics of mathematics, its procedures and possibly the patterns and formulas.

Identification of Teachers' Initial Problems of Mathematics Teaching

Prior the implementation of Lesson Study activities (Marsigit, 2006), the selected Junior High School mathematics teachers who were invited to participate in the workshop of Lesson Study, perceived that to perform good practice of mathematics teaching there are some constraints coming from: lesson plans, students' worksheets, teachers' competencies, students' readiness, educational facilities and equipments, teaching methodologies, allocation of time, number of students and budgeting. Teachers need to improve their competencies of teaching and competencies of teaching contents. They perceived that they need to improve their competencies in preparing the lesson plans and producing students' worksheets. According to teachers, most of the students are not ready or not able to present their ideas; it takes time for them to accustomed to do that. Most of the schools are lack of educational facilities and teachers need to be able to develop teaching media. The most difficult one to implement such good model of teaching practice is about time allocation. Some teachers perceived that it is not easy to take in balance between achieving students' competencies and considering their processes of learning. Meanwhile, a teacher still should facilitate a lot number of student i.e. forty students per class. The teachers hoped that the schools and government support their professional development including the chance to get training, to participate the conferences, to participate in teachers club. The teachers perceived that in the teachers' club they are able to discuss and develop lesson plan and students worksheet. Teachers suggested that teachers' professional development programs should be based on teachers' need; and therefore, it needs such a need assessment prior the programs. They also hoped that the schools and government procure educational facilities and improve their salary.

Lesson Study Activities and the Following Schema

Lesson Study activities let the teachers to reflect and evaluate, in cooperation with lectures or other teachers, their implementation of teaching. Approaches of Lesson Study covered (a) cooperation among students in learning, (b) contextual teaching and learning, (c) life-skill, (d) hands-on activities, (e) interactive process oriented curriculum and syllabi development, and (f)

teachers' and students' autonomy. From those three sites of study, they produced the notions of educational improvement, in term of teacher, student, and lecture. Previous study by IMSTEP (2000) indicated that to encourage mathematics teachers' professional development, all sides in educational system should consider the promotion of: (1) good atmosphere for teaching and learning, (2) various teaching methods and teaching learning resources, (3) chances for the teachers and their students to perform their initiatives, (4) cooperative learning, (5) research class as a model for educational innovations (as Japanese teachers do), (6) teachers' role to develop their curriculum, (7) school and teacher autonomy (8) school-based management, and (9) contextual teaching. The objective of Lesson Study activities was to contribute the improvement of secondary mathematics education by pursuing good practice of mathematics teaching. Lesson Study for secondary mathematics was carried out by mainly Classroom Action Research approach. The results of Lesson Study could be inferred from the view of students, teachers, and lecturers. The data were collected through observations, questionnaires and interviews. Teachers perceived that Lesson Study gave positive results because it could improve teachers' professionalism in finding variations of teaching approaches and teaching methods. It introduced a new model of teaching which enables teachers to increase the variation of teaching on how to conduct classroom teaching and learning process. There were evidences that Lesson Study improved teachers' skill to communicate, to deliver questions, to carry out discussion, and teachers' creativity as well. Teachers perceived that Lesson Study activities were useful to support the implementation of competence-based curriculum and the Curriculum 2013. Following are the results of some research that were conducted through the scheme of Lesson Study:

a. Promoting student's thinking on the concept of lowest common multiple (LCM) through Realistic Approach

The research was to promote student's thinking on the concept of lowest common multiple (LCM) through Realistic Approach in the 4th Grade of Primary Mathematics Teaching (Marsigit, 2006). Specifically, the study was aimed at encapsulating, through Lesson Study, the picture of mathematical thinking that is students' thinking on the concept of Lowest Common Multiple (LCM) at the 4th Grade Students of Primary School in Indonesia. With the ground of the new School-Based Curriculum, we, in collaboration with teacher, prepared the teaching learning of LCM using Realistic Approach. The search of this lesson study strived to uncover the idea of mathematics as a human activity stressed on realistic approach. Teacher organized the class as a process of *guided reinvention* (De Lange, 1996, in Zulkardi, 2006) that is to step in learning LCM by developing instructional environment e.g. let the students to freely chose and develop their methods and aids to solve the problems. The teacher let the students work individually and in group informally to perform horizontal mathematization; and then to anticipate the structure into more formal mathematization activities. The evidences indicated that, in term of the realistic approach, mathematical thinking can be performed through identifying or describing the specific mathematics, schematizing, formulating and visualizing a problem in different ways, discovering relations, discovering regularities, recognizing isomorphic aspect in different problems; transferring a real world problem to a mathematical problem. Mathematical thinking was always started when the teacher posed the prepared problems written in the *Work Sheet*. The students employed their pre-requisite knowledge to perform mathematical thinking. The students employed different ways to perform *schematizing*, *formulating* and *visualizing*. The series of sentences produces by the group indicated first

horizontal mathematization then followed by *vertical mathematization*. In performing the *vertical mathematization* the students need the assistances from the teacher.

b. Developing Mathematical Methods as the Schema of Mathematical Thinking

The research through the schema of Lesson Study strived to develop mathematical methods in learning the total area of a right circular cylinder and sphere as well as the volume of a right circular one of the 8th grade students of Junior High School (Marsigit, 2007). Specifically the aim of the study is to promote students to develop mathematical method in learning the total area of a right circular cylinder and sphere and also the volume of a right circular cone. Specifically, the expected result of the study is to describe students' attempts or efforts in Katagiri S. (2004): *inductive thinking, analogical thinking, deductive thinking, integrative thinking (including expansive thinking), developmental thinking, abstract thinking (thinking that abstracts, concretizes, idealizes, and thinking that clarifies conditions), thinking that simplifies, thinking that generalizes, thinking that specializes, thinking that symbolize, thinking that express with numbers, quantifies, and figures*. It found that in developing teaching learning methods, the teachers need to plan the scenario of teaching, to plan students activities, plan teachers' roles, to distribute the assignments, to develop assesment methods, and to monitor the progress of students achievements. To develop their experiences, the teachers also need to participate frequently in such kinds of workshops or seminars. By using those teaching materials teachers could conduct the teaching and learning process more efficiently. Students enjoyed their learning process because they were involved in observing and doing things. Those teaching materials also improve students' motivation and interest in learning the materials. Although there were many kinds of teaching materials already developed through those Lesson Study activities, there still more topics that need to have or to have better teaching materials.

c. Developing Students' Apperception

In preparation to the larger scale of class-room based research on students' apperception in learning mathematics, Rosnawati and Marsigit (2014), in the series activity of supervising micro-teaching for Undergraduate Students of Mathematics Education, employed Case Study to uncover the nature and the structure of students' apperception in learning mathematics. It found that in order to develop apperception in constructive mathematics teaching, the candidate of teacher should develop and implement: constructive lesson plan, constructive students worksheet, small group discussion, various teaching method, various students interaction, various media and teaching aids, cognitive scheme, students' reflection and classroom-based assessment. Based on the series of observation in microteaching activities supervised by Marsigit (2007-2013), and the latest study Rosnawati and Marsigit (2014), it was found that the apperception of learning mathematics can be developed through considering the rules of practice in the teaching learning as the following:

- 1) Empower the students to be the active learner of mathematics and appeal to their experiences.
- 2) Prepare lesson plan to facilitate the needs of students learning mathematics.
- 3) Prepare various media, teaching aids, and mathematics learning resources and make them close to the students' mathematical experiences.

- 4) Prepare various activities including small group discussion to let the students doing in-depth investigation of mathematical concepts; as well as reflect and conclude their finding.
- 5) Prepare various and flexible method and approach to manage the mathematics classroom.
- 6) Develop activities and materials schema or scenario to achieve students' competencies including the series of activities and materials arrangement in such a way that each topic should form a strong aid for the apperception of the next topic; as well as, its association to the students' mathematical experiences based on the law of concentration, assimilation and correlation in learning activities.

d. Developing Mathematical Problem Solving-Based ICT

In preparation to the larger scale of Lesson Study activities, Marsigit (2011) identified the appropriate criteria for developing ICT to promote problem-solving activities in learning mathematics. It uncovered that in order to motivate the students, the teachers perceived that ICT should have a good lay out, supporting references, clear cognitive scheme, clear applications of mathematics, examples of daily life, and history of mathematics. The teachers indicated that ICT should be based and oriented on students' learning activities; therefore, they suggested that it develop student's autonomous, mathematics drill, and problem solving. It is important that it also should be based on school-based curriculum. Further, such an ICT should support the students in achieving their competencies.

Relating to the needs for developing flexible teaching learning method, the teachers perceived that such an ICT should facilitate all students without any exceptionally. It should be used by the students both individually or collaboratively. Furthermore, it also should make the students feel confident and joyful. To make it happens the ICT should be arranged hierarchically and supported by on line internet resources. Step by step of finding the formulas may fulfill the students' need to learn mathematics. However, it is important to note that it provides various quiz and enough exercises and story problems. To make the students feel more confident it should contain answers for each problem.

It is realistic that every developed single book should deal with students' difficulties in learning mathematics. To overcome such condition, such a book should provide various ways to solve the problems. It was suggested that it provides such a space to get students feedback in order to communicate their ideas with their teacher. Therefore, the teachers though how to develop communicative ICT. The writer of ICT should consider how the students are able to understand the procedures. Short and not long sentences can be employed. The combination of good developed teaching content, curriculum based cognitive schema and the clear of the guidance make the students have their ability to develop their cognitive schema in learning mathematics.

The further crucial point of developing ICT is about its orientation. Presently, there is no further important point to be considered except that the ICT should be based on students learning activities. To meet this criteria such an ICT should employ realistic approach in which the students learn mathematics from the concrete daily life to get direct experiences and useful schema to prepare their activities in developing various model and mathematical procedures. However, there is still an ultimate question on how the ICT do encourage the students to solve

mathematics problems? The teacher then recommended that such an ICT should provide: (1) trial and error schema, (2) activities of making diagrams, (3) activities of manipulating the tables, (4) finding the pattern, (5) breaking down the goal, and (6) considering possibilities.

Conclusions

From the series of Lesson Study activities in the last decade, in different context of primary and secondary mathematics teaching in Indonesia, it can be learnt that Lesson Study activities provides abundant scheme to promote good practice of mathematics teaching. The following are the findings related to the aspects of performing good practice of mathematics teaching i.e. the teachers: (1) be more concerned about their students differences, (2) strived to facilitate students activities, (3) employed various method of teaching, (4) employed various method of evaluation, (5) strived to connect the relationship among Subject-Matter, (6) developed Contextual Teaching Learning (CTL) approach, (7) developed various interaction, (8) employed small group discussion, (9) developed the scheme for competences achievement, (10) facilitated their students to be more active, (11) employed various teaching aids, (12) employed various learning resources, (13) strived to implement new paradigm of teaching, (14) were more passion to facilitate their students, and (15) have their habit to reflect their experiences of teaching. While the students: (1) were more interested to learning object, (2) were more motivated to engage in teaching learning processes, and (3) were more active in the class. It also suggested that to promote good practice in the teaching of mathematics, the central government needs to: (1) redefine the role of the teachers i.e. they should facilitate students' need to learn, (2) redefine of the role of principals i.e. they should support the professional development of teachers by allowing them to attend and participate in scientific, meetings and trainings, (3) redefine the role of schools i.e. they should promote school-based management, (4) redefine the role of supervisor i.e. they need to have similar background with the teachers they supervise in order to be able to do academic supervision, (5) promote better collaboration between school and university, and (6) redefine national evaluation system.

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