

CRITICAL ISSUES ON MATHEMATICAL COMMUNICATION: LESSON LEARNT FROM LESSON STUDY ACTIVITIES IN INDONESIA

Didi Suryadi
Indonesia University of Education

This paper provide examples of critical issues on mathematical communication derived from lesson study activities in Indonesia. The issues include classroom environment condusive for improving the quality of discussion, group working to facilitate students engagement in exploring mathematical meaning and understanding, the role of rich mathematical tasks that enable students to actively involved in mathematical communication, and students presentation.

Introduction

Piloting activity of lesson study has been implemented in three districts since 2006. Three universities (UPI, UNY, and UM) are responsible for implementing the pilot program supported by Japan International Cooperation Agency (JICA) and Ministry of National Education of Indonesia. It is our belief that an effort for any professional development deals with the creation of professional learning culture within the workplace. Experiences to work together with teachers, principals, government, and JICA experts are mainly focused on developing model for educators professional learning that empower our community of practices. In facing that challenges we are pleased being introduced to lesson study that has very long history within Japanese educational culture. Our experiences in contextualizing lesson study in Indonesia, has lead us to the development of our underlying philosophies, working frameworks and key success factors in implementing lesson study. We view lesson study as professional learning model by studying lesson collaboratively based on the principles of collegiality and mutual learning to continuously improve the quality of teaching and learning.

In trying to improve the quality of mathematics teaching and learning, Junior Secondary Mathematics Teachers in the three piloting districts, are working together collaboratively by studying mathematics lessons through a lesson study scheme. This paper provide examples of some critical issues deal with mathematical communication arised from lesson study activities in Indonesia. Currently, our mathematics teachers are struggling to make improvements on the process of teaching and learning, while at the

same time they also need to consider national policy on the system of national examination.

Theoretical Framework

Mathematical communication is a way of sharing ideas and clarifying understanding on mathematics learning. In mathematical communication, ideas coming from the process of solving problems become objects of reflection, refinement, discussion, and amendment (NCTM, 2000). When students are challenged to solve a problem, they would have opportunity to think about and try to solve it. Difficulties that students have to solve the problem, different ideas, and different solutions are potential resources to encourage students to share, compare, justify, explain, or discuss the problem. Interaction among students during whole-class activity provide opportunities to develop their mathematical abilities including conceptual and procedural understanding (Takahashi, 2006). Students interaction in which mathematical ideas are explored from different point of views could help the students to deepen their understanding, and develop their ability to communicate, explain, justify, and discuss mathematical ideas.

In order that students have opportunity to think, communicate, and discuss their ideas, teachers could provide mathematical tasks including procedural and nonroutine problems. Procedural tasks for which students are expected to have well-developed algorithmic approaches are usually not good candidates to create mathematical discourse (NCTM, 2000). While a nonroutine problem is a problem that provide challenges for individual so that he or she must “(1) be aware of the situation, (2) be interested in resolving the situation, (3) be unable to proceed directly to solution, and (4) make a deliberate attempt to find a solution” (Lester, 1980).

A potential approach that provide opportunities for the students to actively involve in rich conversations, is an open-ended approach. This approach include formulating a problem mathematically, investigating various approaches to the problem, and posing advanced problems (Nohda, 2000). In the first situation, a teacher shows the original problem or situation, while students are asked to formulate the problem confronted using their own learning experiences. The second situation relates to the students’ activities in attempting to find out their own solution based on their frame of

reference and experiences. Considering that there are some different solutions, the teacher then facilitates a classroom discussion in which students have opportunity to see, relate, compare, or other relevant activities related to the problem solutions so that they finally come up to more sophisticated solutions. In the third situation, the students are asked to pose more general problems on the basis of their activities in earlier situations.

The type of problems presented in an open-approach should meet three characteristics, namely the process of problem solution is open, the final solutions are open, and the ways to develop extended problems are open. Since the main goal of the method is not emphasized on producing correct answers but mostly on promoting students' mathematical as well as creative thinking, evaluating students' responses are quite difficult for the teachers. However, in order that students' responses can be evaluated easily, teachers need to consider the following criteria derived by Shimada in 1977: (1) fluency- how many solutions can each student produce?, (2) flexibility- how many different mathematical ideas can each student discover?, (3) originality- to what degree is a student's idea original?, and (4) elegance- to what degree is students' expression of his or her idea simple and clear?.

Lesson Learnt from Lesson Study Activities

Piloting activities on mathematics lesson study in Indonesia have been implemented since 2006. During this period, junior secondary mathematics teachers in three districts (Sumedang in West Java, Bantul in Central Java, and Pasuruan in East Java) have been trying to improve the quality of mathematics teaching by utilizing the scheme of lesson study activities including Plan, Do, and See session. In this period, they have tried to make improvements on some aspects of classroom activities including classroom setting, classroom communication, group work, and students' presentation. Although mathematics teachers have tried to make some improvements, it seems that several critical issues especially related to the improvement of students' mathematical communication need to take into consideration.

Classroom Setting

Each student has the same right to be accessed by his or her teacher. It means that teachers need to create a classroom setting so that they could easily access all students to see whether the students need some helps or no. Traditional ways of teaching as indicate in Figur 1a are commonly used in mathematics teaching in Indonesia. In this type of teaching, students do not have much opportunity to communicate their ideas. Teachers tend to dominate classroom communication by explaining concepts, demonstrating examples, and guiding questions and answers or discussions. After getting involved in lesson study activities, especially in the discussion session, teachers from piloting districts then realise that one-way communication need to be changed in order that they could easily access all the students and provide chance for them to share, communicate, and discuss their ideas. Some teachers try to use U-shape as indicate in Figure 1b.



Figure 1a



Figure 1b

By the U-shape setting, teachers can go around the classroom to give guidance, listen to students' conversations, pay attention to important ideas from the students, and ask as well as answer students' questions. Although the U-shape settings are initially aim at facilitating effective communication among students and between students and the teacher, most teachers still have difficulties to make use of students ideas and infortant information to encourage collaboration among students or to perform classroom discussion.

Group Working

An environment that is conducive to promote discussion in which students could share ideas, explain their understanding, and compare different solutions, is frequently arised in teachers' discussions. They propose group working as an alternative approach to facilitate collaboration among students. However, some teachers are commonly focused their attention to just looking for the correct unswers. They some time forgot to consider students' contributions including to elicit incorrect ideas and asking students to justify and explain their methods for solving the problems. In fact, incorrect ideas are some times very important to start whole-class discussion. Asking students to provide justification can encourage them to reorganise their thinking so that finally come up with better understanding. By exposing their thinking, students may have to negotiate the meaning of mathematical ideas with others, and to explain and justify their reasoning so that they can convince others of the legitimacy of their ideas. Through this process of negotiation and justification, students will have higher motivation to think more deeply about their own ideas and those of other students.

Type of problems presented in small group activities, is frequently become the source of students' lack of communication. For example, a mathematical task to show that the area of a ball surface is $4\pi r^2$ by sticking on small piece of paper cutting from circles, doesn't provide a challenge for the students to communicate their mathematical ideas (Figure 2). Alternatively, more open problems such as on finding ways how to count the number of maches needed to form 3, 10, and 100 squares could create more conducive environment to discussion (Figure 3).



Figure 2



Figure 3

Type of Problems Presented

Rich mathematical tasks are key factors in classrooms that have communication as the main goal (NCTM, 2000). Open-ended and challenging problems that related to students' prior knowledge are conducive to discussions because they encourage students to think collaboratively. Based on current lesson study activities in Indonesia, some teachers still unaware of the fruitful of open and challenging mathematical tasks. They still need to be convinced that tasks with multiple levels of access will enable students with different levels of background knowledge and mathematical abilities to work on the problems. Besides, as they move through the solution process, collaboration among the students will be arised accordingly to share their own understanding and to negotiate meaning.

Group Presentation

After the students getting involved in small group activities to solve a problem, it is commonly found that teachers asked the students in group to present their solutions. A reason for this activities from the teachers' side is to support their students' learning by encouraging them to communicate, explain, share, compare, and justify their solutions or mathematical thinking to their peers and teachers in the oral manner. Establishing this type of activities in the mathematics classroom involves inviting students to share their solutions and strategies, and pose questions and answers. By exposing their thinking, students may have to negotiate the meaning of mathematical ideas with others, and to expalin and justify their reasoning so that they can convince others of the legitimacy of their ideas.

Since the mathematical tasks students tried to solve in small group activities, are not merely challenged the students to produce multiple level and different solutions, the discussion on solution strategies are not happened accordingly. Therefore, students' presentations are frequently make the students lack of motivation to get involve in discussion.

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