A Study of Student’s Mathematical Communication in Teacher Professional Development

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Abstract: This case study was conducted by qualitative research design consisting ethnographic approach, teaching experiment, protocol analysis and analytic description. The objective of the study was to analyze cognitive aspect and emotional aspect in students’ mathematical communication in teacher professional development innovates by lesson study and open approach. The targeted group was 23 first graders at Ban Bungniambungkrinoon School, Khon Kaen Province. Three Problem situations; school bus problem (6+3+4), playing sand in playground (7+5-8) and eating apples(13-4-2) was used as learning activity in this teaching experiment. The data from classroom teaching episodes was analyzed by protocol analysis according to characteristics of mathematical communication as an cognitive aspect proposed by Emori (2005), then analyzed emotional experience as an emotional aspect proposed by Inprasitha (2001). Research findings revealed that mathematics classroom taught by open approach through 4 steps; posing open-ended problem situation, student’s self learning, whole class discussion and summary through connection; three characteristics of mathematical communication in view of cognitive aspect found in classroom were rigorousness, economy and freedom. Moreover, in view of emotional aspect we found that student have emotional experience in every step of teaching. Emotional experience that often occurred were self confidence, excitement and enjoyment, introspectiveness, paying attention, accepting other ideas, awaiting answers and amazing respectively. From the findings of this research, not only the cognitive aspect could be evaluating mathematical communication in classroom, but also emotional aspect can help teacher to understand students’ mathematical concept and develop them.

Key words: mathematical communication, cognitive aspect, emotional aspects, open approach and lesson study

1. Introduction

Thailand was jointly participation with the Trends in International Mathematics and Science Study (TIMSS) in 1999. Mathematics result shown that Thai students’ score was 27 from 38 countries in the world. In 2007, the rank was 29 from 48 countries in the world. In 2003 and 2006 Thailand was jointly participation with the Program for International Student Assessment (PISA). All scores in mathematics, science and reading were low. These result indicated that the competency of Thai’s people in future might gain a problem. Therefore, Thailand needs to develop mathematics competency. This event was reflect about how fail of Thailand’s education reform in 10 years.


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educational reform in Thailand still have many problems to improve Thais’ education development. Thailand has low capability competition compare with some other average developed countries. Students’ scores of mathematics, science and others subject achievement seems to reflect educational quality. It indicated lower than the other countries. In generally, Thailand education is low quality.

The deterioration state of educational quality status was failed from educational reform. Inprasitha (2006) stated that although Thailand enacted the act of parliament of education and tried to reform education in 1999. Most of teachers had stilled traditional teaching style — focus on teaching over all of contents but do not emphasize on students learning process. Wasee (2000) stated that the heart of educational is learning reform. Fernandez et al. (2003) proposed that teacher need to know how to understand students’ learning process and know how to verify their teaching practice.

Fundamental ideas of lesson study have had the most effective method to improve teaching development in classroom. These ideas had applied for the lesson development in real classroom context. The challenges that attribution such as change need to happen for develop students’ learning in classroom, collaboratively exchange knowledge and problem with other teachers and the group of teacher to perceive the goal of teaching too (Inprasitha and Loipha, 2008). Lesson study had attention from around the world as the ways for develop teaching and learning mathematics (Inprasitha and Loipha, 2008). Integration of lesson study and open approach used for pilot schools in Khonkaen province since 2007 by center for research in mathematics education Khon Kaen University as teacher professional development focuses on students’ learning process.

Emori (2005) stated that mathematical communication are mathematical communication structure be suspicious in communicator participate. Mathematical communication structure has three characteristics rigorousness, economy and freedom of thinking.

Sierpinska (1998) stated that communication can identify educational system. Emori (2005) proposed that almost mathematics education issues related to mathematical learning communication. Learning is adapted stimulus surrounding and create a new one by learners’ knowledge keep in mind. Learning process needs to use communication process. Study of communication is the most important study in mathematics education. The Third APEC-Tsukuba International Conference Innovation of Classroom Teaching and Learning through Lesson Study-Focusing on Mathematical Communication announced communication development in classroom are important for improve students’ mathematical thinking. Khalid (2007) stated that open-ended problem was used for encouraging communication in classroom. Students had opportunity to communicate and discussion about strategies for solving various problems.

Nohda (2000) expressed that the features of open-ended classroom are discussion various students’ ideas and develop these ideas through their classmate experiences and teacher advice. So, classroom focus on open-ended approaches could contribute students’ interest and share their ideas for discussion and mathematical communication.

Open-ended approaches have four steps. The first step is posing open-ended problems situation. The second step is students’ self learning. The third step is the whole class discussion and the last step is summary with connection. Every step shows that communication help student to learn mathematics.

Piaget (1981 cited in Inprasitha, 2005) asserted that there is no any cognition mechanism which is without affective components. McLeod (1992) proposed that if affective issues are integrated in a study of cognition then the mathematics education research will be strengthen. Hannula et al. (2004) proposed that the important research problems in the present are making understanding of the relation between cognition and affection. McLeod (1992) stated that in the past, there are less of researchers playing attention to consider the emotion in their study.
Nowadays, there is the trend to study which gives more details about the emotion and cognition process. This study was done in school context under the center of research in mathematics education by using lesson study and open approach innovation in mathematics classroom for three years. Open approach is method of teaching in the cycle of lesson study. It means that they are many peoples, such as teacher, teacher observer, researchers, research assistants, school coordinator and experts, all of them are collaboratively in plan, do and see in teaching and learning process. The objective of this study was to analyze cognitive and emotional aspect in students’ mathematical communication in teacher professional development innovates by lesson study and open approach.

2. Theoretical Framework

Two frame works was used in this study for analyze data (Figures 1–2).

![Figure 1 Framework for Collecting and Analyzing the Data](image1)

![Figure 2 The Process of Lesson Study and Open Approach](image2)

3. Methodology

This research was Qualitative Research included the Ethnographic Approach and Case Study Approach,
Teaching Experiment and Action Research as follows: the targeted group were 23 first graders at Ban Bungniambungkriinoon School for teaching experiment, then one group of three students was chose from that class for a case. Protocol analysis was applied for analyzed data. Three Problem situations; school bus problem (6+3+4), playing sand in playground (7+5-8) and eating apples (13-4-2) was used as learning activity in this teaching experiment. The data from classroom teaching episodes was analyzed by protocol analysis according to characteristics of mathematical communication as a cognitive aspect proposed by Emori (2005), then analyzed emotional experience as an emotional aspect proposed by Inprasitha (2001).

4. Findings and Discussions

4.1 Findings for the First Objectives
Open Approach is a method of mathematics teaching in classroom consists of 4 steps: posing open-ended problem situation, student’s self learning, whole class discussion and summary through connection. Mathematics classroom were give an opportunity for students communicates mathematics ideas in every steps. The result indicated that three characteristics of mathematical communication in view of cognitive aspect found in classroom were rigorousness, freedom and economy respectively. The result showed that rigorousness is the most characteristics found in every steps of the teaching. Freedom and economy characteristics were found in secondary.

In each step of open approach: the first step rigorousness characteristic of mathematical communication between teacher and students in posing the problem step was found as a majoring characteristics in order to support student to understand problem situation and able to access problem situation. Communication in this step needs to focus on common understanding among them.

In second step, students have more opportunities to communicate. Problem solving in classroom focused on divergent thinking and creative thinking, it supports student to produce different solutions. Communication in this step needs characteristics of rigorousness and freedom in order to produce various ideas and solutions.

In third step, students were able to present their own ideas and discuss with teacher and classmates questions. The students have to present their own ideas clearly both themselves and their classmates. Communication in this step needs characteristics of rigorousness.

![Figure 3 Students’ Self Learning](image-url)
The last step, the teacher tried to propose the matter of lesson through connecting students’ ideas in order to polish students’ understanding. Communication in this step needs characteristics of rigorousness which help student make sense with correct concepts.

4.2 Findings for the Second Objectives

Open Approach is a method of mathematics teaching in classroom consists of 4 steps: posing open-ended problem situation, student’s self learning, whole class discussion and summary through connection. Mathematics classroom were give an opportunity for students communicates mathematics ideas in every steps. The result, from view of emotional aspect, indicated that student have emotional experience in every step of teaching. Emotional experience that often occurred were self confidence, excitement and enjoyment, introspectiveness, paying attention, accepting other ideas, awaiting answers and amazing respectively.
The first step of teaching, posing problem situation, the teacher focused on non-routine problem situation comprising with materials design that make excitement for student. The problem situation built emotional experience like exciting, enjoy and enthusiasm. Teacher’s questioning helped students to understand problem situation. It causes students have self confidence in their own solutions.

In second step, students shared their solving open-ended problem together. Students were able to solve given problem and explored and shared different solutions. It showed that students have most of emotional experience in introspectiveness. When they were able to think by themselves, they feel proud, satisfy, exciting and enjoy, confident and wait in their solutions expectantly. In addition, as students shared mathematical ideas, it causes students have emotional experience in accepting other ideas from their classmates. When someone in the classroom raised some different arguments, it caused them to suspect and uncertain.

In the third step, students were able to present their own solutions and discuss on classmates and teacher questions. In this step, students answer questions confidently. It showed that students have emotional experience in their self confidence and exciting and enjoy. When some student presents their idea on face of blackboard, other students paid more attention to listen. It caused students have emotional experience like interesting, concentrating their presentation, aware and accepting other ideas. If someone disagreed with those solutions, they have emotional experience in seriously disagree.

The last step, the teacher tried to propose the matter of lesson through connecting students’ ideas and questions about expected concept that student need to learn in the lesson. In this step, students just learned their classmates’ solution, then student have emotional experience in confidence with their own method that have learned before.

4.3 Discussions

4.3.1 Discussion from cognitive aspect

As a result, the characteristics of communication from cognitive aspect in students’ mathematical communication in each step of teaching, we found that rigorousness is the most characteristics found in every steps of the teaching. Freedom and economy characteristics were found in secondary. Because of open approach was used in this classroom, it give opportunity for students to communicate mathematically. Students have opportunity to share discussion with their classmates and teacher. It conforms to Nohda (2000) claimed that the characteristics of open-ended approach have to discussion with students’ various ideas and develop those ideas and their perspectives through common experiences and under teacher’s advise. Thus, the classroom focuses on open-ended approach are able to construct common interest which focuses on discussion and mathematical
communication. Furthermore, the characteristics of communication from cognitive aspect in students’ mathematical communication in each step of teaching, we found that rigorousness, economy, and freedom characteristics respectively of students’ thinking was the most important cognitive aspect in order to teacher’s understanding students’ mathematics structure in classroom. It may be claimed that we could use this frame for evaluate students’ communication. It conforms to Emori (2005) claimed that the rigorousness, economy, and freedom characteristics of communicators’ thinking for evaluation mathematical communication in classroom.

4.3.2 Discussion from emotional aspect

In this study the emotional aspect has been occurred. Open approach as method of teaching in mathematics classroom was giving an opportunity for students communicates mathematics ideas in every step. From view of emotional aspect, students potential in doing mathematics, students have emotional experience in every step of teaching. Emotional experience that often occurred were self confidence, excitement and enjoyment, introspectiveness, paying attention, accepting other ideas, awaiting answers and amazing respectively. The results shown that students have freely explored how emotional experience can be expressing their thinking as they can do. In addition, students have enjoy in learning, its help them feeling happy too.

It is the most aspect to develop students’ attitudes toward mathematics learning. Therefore, teacher needs to understand students’ emotional experience in order to make sense of students’ emotion and their feeling. It conforms to Emori (2005) claimed that good lesson could develop students’ thinking and their feeling. Thus achieving the students’ emotional experience is a useful to understanding the students’ conceptual development and it is a useful to help student discovery the solutions. In addition, emotional aspect could enhance students in mathematics problem solving experience as it reflects students’ ideas directly related to real life experiences by themselves.

5. Recommendations

From the findings of this research, **Open Approach and Lesson Study** should add in the mathematics classroom provides a platform for mathematics education teachers.

5.1 Implementations for Teaching and Learning

(1) The teacher could be use open approach as teaching method for school mathematics and doing their research for learning development with mathematical communication. Addressing an improvement or change method of arrangement mathematics activity, teachers’ role needs to search for student’s process of meaningful learning in classroom. In addition, student center is the most important in mathematics classroom. The teachers, who teach school mathematics, may be use open approach to integrate mathematics content knowledge, mathematical processes and affective domain. These matters are difficult to happen in mathematics classroom for students’ mathematical communication as mathematical learning processes and develop affective domain.

(2) The teachers, who teach school mathematics, may be use open approach to integrate with lesson study. This process need to collaborative lesson plan, observation, and reflection. It make teacher have opportunity to develop themselves and change the role of their teaching.

(3) The teacher use open approach should be give an opportunity and encourage her students to explore, communicate, argue, discus, check, proof, reasoning, and present their ideas and solutions. At the same time, student doing activity, the teacher do not interfere student thinking either not to show any ideas or not to give some data for solves that problem.
5.2 Further Research

(1) Educational Institute and Research Institute can be use research results for identify research trend for develop learning and teaching mathematics consistent with educational reform focus on students’ learning process.

(2) The teacher as researcher plays the expectation role of teaching follow Thailand enacted the act of parliament of education in 1999. They can use protocol analysis to study students and their classroom in each aspect such as analyze students’ mathematical problem solving processes for seek method of learning with understanding in mathematical concept. Protocol analysis can help teacher for analyze the nature of mathematics in the compulsory education that students can learn by themselves. Protocol analysis can help teacher as researcher for understanding more detail about data and improve their mathematics lesson.

(3) The researchers wish to discover the model or method for improve model of classroom development. They need to collaborative with the school teacher in the long term and to be continued in order to lead the answers. This result can help for shift classroom development.

(4) The researcher, who wish to discover the model or method for improve model of classroom development need to perform both theory and practices in order to see the conformation of reality in practice for describe more detail in data, which those researchers can extend their study.

References:
First announcement (2007). The Third APEC-Tsukuba International Conference Innovation of Classroom Teaching and Learning through Lesson Study III — Focusing on Mathematical Communication, CRICED, University of Tsukuba.