A Thai Study of Mathematical Creativity of Students in the Lesson Study and an Open Approach Context

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Abstract: *The purpose of the study was to investigate Thai students' creative thinking in the lesson study and the open approach context by the participant observation and assessment of the students' mathematical creativity. The target group was 7th grade students who had been taught continuously for six years through the lesson study and the open approach. It was the class where the teacher had experience in teaching through the lesson study and the open approach regarding the concept of Inprasitha (2011a). In addition, this school has been the model school to apply the innovation under the project of the teacher professional development with the lesson study and the open approach for over 10 years since 2006, organized by the Center for Research in Mathematics Education (CRME), Faculty of Education, Khon Kaen University. The results of the study revealed that all of the students taught in the lesson study and the open approach context had creative thinking consisting of divergence, fluency, flexibility, and originality. Moreover, the results of the study were beneficial for the Mathematics teachers to apply the instructional guidelines to their own teaching in order to encourage the students' creative thinking.*

Keywords: Creative thinking, Lesson study, Open approach

Introduction

Creative thinking is considered one of the human abilities that is more qualitative than other abilities, and that the crucial factor for supporting the progress of the country (Panmanee, 1998). Thus, developing the potential in creative thinking will help develop human intelligence, and one will be clever, able to solve problem quickly, and develop new things more remarkably as compared to others. In addition, it can help people to live happily and benefit the society abundantly (Charoenwongsuk, 2006). The Ministry of Education (2008) has prescribed the policy on developing juveniles in the country for the 21st century, which mainly encourages the learners to have creative thinking skills. However, as the results of the previous educational management have shown, it was found that the norm of the students' creative thinking was typically low (Office of the Permanent Secretary Ministry of Education, 2012). Although Thailand places importance on developing the teaching profession in order to develop the quality of instructional management as well as the learners, it cannot improve the Thai education substantially (Siamwasana et al., 2012). The innovation of the lesson study is one of the approaches that Japanese teachers have been applying to the teaching professional development for ages, and it is now widespread in many countries, especially in the United States. It is generally acknowledged that it can help the teachers to develop themselves and students' learning simultaneously (Inprasitha &

Loyphar, 2008). In Japan, the lesson study is the practical method to develop the profession and the lesson through the teachers' cooperation. The teachers participation in learning more effective practice leads to the promotion of developing the teachers and better learning achievement of the students (Lin, 2009). As for Thailand, the lesson study and the open approach that is in the form of the teachers' professional development in Japan have been applied as the guidelines for developing the teaching profession since 2006. The initial schools that applled the lesson study and the open approach consist of Kookham Pittayasan School, which is the target of this study, and Choomchon Banchonnabot School in Khon Kaen province. After implementing the project, it was found that the lesson study and the open approach can develop the teachers and the class. It also develops the students' thinking and learning process literally (Inprasitha, 2011a).

Therefore, to ensure that the lesson study and the open approach can be practically applied to develop the teaching profession and the Thai students' creative thinking with regard to the policy of educational reform and the national development strategy, the researcher carried out this study to explore whether or not the lesson study and the open approach can encourage the Thai students' creative thinking. As a result of the study, the teachers who participated in the project were more confident in teaching. In addition, the teachers who taught other subjects could apply the instructional guidelines to adapt and develop their students' creative thinking and the national education policy.

Background

Mathematical Creativity

Mathematical creativity is defined differently. Poincare (1948), for example, described that the mathematical creativity referred to the ability to construct mathematical alternatives leading to success. Additionally, Haylock (1987, p.59) classified mathematical creativity regarding its importance in two types: the ability to overcome obstacle conditions of mathematical problem-solving; and the ability to produce various kinds of products in the mathematical situations. Moreover, Saito (1998, p. 19) discussed that creativity in a school context referred to the ability to produce new valuable things, and valuable things assessed by group members while the students were coping with the problems. It also referred to an individual characteristic. Furthermore, Brunkalla (2009, p.257) pointed out that there were 3 important methods relating to the students' mathematical creativity, noting that 1) the abstract creativity related to the model construction that reflected the real world. The problems were solved by using mathematical tools, and the students could learn by themselves; 2) the connective creativity referred to awareness of determining what mathematical tools could be applied to the new situations and cope the problems with the new methods; and 3) the research creativity was the recovery the new mathematical tools to fit for the problems that have never been solved.

In conclusion, the mathematical creativity is the ability of thinking in solving problems by different, various, and new methods. The process of mathematical creativity appeared in the context rather than in emptiness (Williams & Yang, 1999; cited in Kao, 2007). Thus, encouraging the students' creativity needing to be provided an open-minded atmosphere and the opportunity for the students to express different opinions, to raise the questions freely, and to give the students' rights to select the learning resources and the methods freely (Huai-en, 2004, p.8).

Lesson Study and Open Approach Context in Thailand

The lesson study is the current issue in which many countries are interested. As a matter of fact, the lesson study reflects the process of the teacher's attempt to develop the teaching methods gradually in cooperation with other teachers in order to determine and criticize one's teaching techniques. Additionally, the lesson study played the role as a tool for the teachers to develop and investigate their teaching. Thus, the lesson study became interesting at an international level (Baba, 2007, p.2).

The open approach is the teaching method that aims at encouraging each student to learn Mathematics with their own power and capability. For this sense, the teachers need to understand the students' concepts as much as possible so that it would be a guideline for the teachers to stimulate, support, and provide learning experiences for the students. Thus, they could develop their autonomous learning according to their potential (Loypha & Inprasitha, 2004, p.19). Moreover, Nohda (1993, p.8) added that the class implementing the open

approach could share the interests to the whole class with a focus on discussion and mathematical communication. In addition, the process of assessing the open approach focuses on the process of mathematical thinking and creativity of the students rather that the correct answers. Besides this, Inprasitha (2011b, p.56) defined the open approach that "it is the teaching guideline consisting of 4 steps; posing open-ended problem, students' self learning, whole class discussion and comparison, and conclusion by summing-up by connecting students' emergent mathematical ideas".

Implementing the lesson study and the open approach in the school for developing the Mathematics teacher profession in Thailand successfully is quite difficult. It still encounters the problems and takes time to carry out and to find out the suitable strategies. As the result, Inprasitha (2012, p.234-74) was aware of such a problem and provided the context that encouraged the teachers to work together in the school and led to the development of mathematical learning, which comprised 1) providing the team for the lesson study to work together continuously, consisting of the teachers, the observation teachers, the administrator, the educational supervision, the student teacher, the researchers, and the specialists from the Center for Research in Mathematics Education; 2) providing time for the teachers to design the lesson plans, to observe the class, and to reflect the lesson at least once a week; 3) developing the lesson plans based on the open approach and open-ended problem situations continuously and regularly; 4) applying the mutual lesson plans to the real classroom and the teachers needed to follow the four steps of the open approach, to use the main and supplementary materials, and to set the team who took part in planning the lesson plans for observing the classroom continuously and regularly to record the students' thinking methods, the observation items, the teachers' roles, the problem issues, and the new occurrence in the classroom. This was done to compile the issues occurring in the class for adapting and developing the further lesson plans; 5) reflecting the issues that had been already planned, on-going issues found in the real classroom, and problems and obstacles continuously and regularly to take those issues into consideration for adapting and developing the further lesson plans; and 6) inviting the specialists in the country and from the foreign countries to give the special lecture for the teachers and other related people in the school, and to visit and observe the teachers' classroom. The teachers might take this opportunity to take advantages from the suggestions, and to share opinions and experiences with other people. Moreover, it could encourage the teachers' moral support for working in the school.

The above-mentioned context preparation was implemented in Kookham Pittayasan School since 2006. The Bureau of International Cooperation Strategy and the Office of

the Higher Education Commission supported the Center for Research on International Cooperation in Educational Development of Tsukuba University in Japan to propose the project "A collaborative study on innovations for teaching and learning mathematics in different cultures among the APEC member economies to the Human Resource Development Working Group", to the APEC HRDWG Conference. It was approved and carried out continuously for 5 years from 2006 to 2010. This project was highly acknowledged by the APEC HRDWG Conference in terms of being a continuous project rather than a 1-year project. Additionally, this project was considered the best practice for applying the innovation of the developed countries to improve the quality of education of the developing countries in the APEC members.

In 2009, the Office of Higher Education Commission and the Office of Basic Education Commission assigned the Center for Research in Mathematics Education to carry out a pilot study to implement a lesson study and an open approach under the project on the development of the Mathematics teaching profession through the lesson study and the open approach. Kookham Pittayasan School was the learning resource for the pilot extension among the nineteen schools.

The previous performance of Kookham Pittayasan School under the supervision of the Center for Research in Mathematics Education resulted in an international impact. At the national level, it resulted in many policy sectors, for example the Office of Higher Education Commission, the Office of Basic Education Commission, and the Office of Education Council. It could be noticed that the innovation of the lesson study and the open approach carried out in Kookham Pittayasan School was acknowledged at the national and international levels, that it could probably change the teachers and classrooms, and help the student to develop their thinking and learning process. Moreover, it could be the basis of a new trend to develop the Mathematics teaching profession that aims at developing the practical performance, and displays the guidelines to develop an innovation that brings about the model of practical success in developing the teaching profession sustainably in the future.

Method

Target Group

The purpose of this study was to investigate the students' creative thinking in the lesson study and the open approach context. The target group consisted of eight 7th grade students who studied in the first semester of the academic year 2015, and who had been taught through the lesson study and the open approach for six years, at Kookham Pittayasan School, Sumsoong District, Khon Kaen Province. It was a model school that had been continuously applying the innovation under the project of developing the Mathematics teaching profession through the innovation of the lesson study and the open approach, held by the Center for Research in Mathematics Education, Faculty of Education, Khon Kaen University, for over ten years since 2006.

The implementation of the project in the school will be a collaboration between the teachers, the observation teachers, the student teachers of Program in Mathematics Education, Faculty of Education, Khon Kaen University. The student teachers will be trained to have the knowledge and experience on innovative lesson study and open approach for four years before leaving teaching. In this research**,** the teachers, the observation teachers, the student teachers served as team lesson study, by design the lesson plans, to observe the

class, and to reflect the lesson at least once a week, and as who provide information needed to research.

Research Procedures

As this study investigated the students' creative thinking in the lesson study and the open approach context, the researcher selected the school which carried out the lesson study and the open approach based on Inprasitha's concepts (2012) continuously and regularly at least six years.

The researcher reviewed the synthetic reports of the academic management styles in the schools where it applied to the innovation of the lesson study and the open approach based on Inprasitha's concepts (2012). In addition, the researcher inquired about the information from the teachers, the observation teachers, the student teachers, and other related people in order to estimate the target group. The procedures of investigating the students' creative thinking comprised observing, recording a video, gathering the students' products from all three units with seventeen lesson plans, and evaluating the students' mathematical creativity based on the theoretical framework of Saito (2008) consisting of four types; divergence, fluency, flexibility, and originality, are described in assessment criteria.

Research Instruments

The research instruments consisted of the seventeen lesson plans that followed the teaching procedures based on the open approach. Those were the lesson plans that had been continuously developed since 2006 to the present time by the team of the lesson study in 7^{th} grade and the specialists of the project. During the instruction, the researcher observed the behaviors, recorded a video while the students were accomplishing the activities, and analyzed the students' mathematical creativity at the end of each lesson plan by evaluating the students' products. After implementing all seventeen lesson plans, the researcher examined the students' mathematical creativity individually according to Saito's assessment form (2004).

Assessment Criteria

The researcher employed the assessment criteria for creative thinking based on the theoretical framework of Saito (2008) consisting of four types; divergence, fluency, flexibility, and originality, which was applied to evaluate the mathematical creativity as the follows.

Divergence was evaluated by means of the numbers of all correct and incorrect answers that the students could solve the problems, and marked each answer as one point. The total mark was represented as.

Fluency was evaluated by means of the numbers of the correct answers, and marked each answer as one point. The total mark was represented as.

Flexibility was evaluated by means of the types of the answers, grouped each type of the answers, and marked each type of the answers as one point. The total mark was represented as.

Originality was evaluated by means of the type of the original answers that had never occurred in the instruction of the target teachers, and marked each type of the original answers as one point. The total mark was represented as.

Results and Discussion

When assessed students' work from group activities of 17 lessons, we found that all group of students showed creative thinking in all components such as Students' work from group activities Make a pond with these following locations.

- An equal distance from the school and the clinic.
- The location closest to the home of the village elder.

Idea of group A, Use a ruler to measure the distance from the school to the clinic. Split distance in half and draw a perpendicular to the point where half of a distance. Then draw a perpendicular to the split line to the home of village elder.	**Idea of group B,** Use a ruler to measure the distance from the school to the clinic. Split distance in half and draw a perpendicular to the point where half of a distance. Then, find the closest distance from the home of village elder and the perpendicular by using a dividers. The point to build a pond is where the line tangent between the circle and the perpendicular.	**Idea of group C,** Use a dividers to draw circles with a radius equal. The center of the circle is the school and the clinic. And the intersections of radius equal circles are the point that make an equal distance from the school to the clinic. Then draw a straight line through all points and draw one more from the home of village elder to nearest intersection

Figure 1 Works activities of the group A, B, and C

The pictures above show the different ideas between a groups of students. When each group presented their own work to the class then students learned and shared their opining together that in created more new ideas. And everybody had the best conclusion that is "Using a dividers to draw two circles with a radius equal and the center of a circle is the school and the clinic. Then, draw a straight line through the point where two circle intersect that make and equal distance from the school to the clinic. After that, draw a circle that come together with a straight line before to get the position to make a pond.

When examining the students' mathematical creativity individually according to Saito's assessment form (2004). The results of the study revealed that all of the students in the lesson study and the open approach contexts had creative thinking consisting of divergence, fluency, flexibility, and originality in all items. The mean scores ($\bar{x}$) and standard division (S.D.) of each type of creative thinking were $\bar{x}_{divergence}$ = 7.3 (S.D. =2.38), $\bar{x}_{fluency}$ = 6.7 (S.D. = 2.19),

$\bar{x}_{flexibility}$ = 1.4 (S.D. = 0.32), and $\bar{x}_{originality}$ = 0.4 (S.D. = 0.27), respectively. Results show that score of divergence and fluency were high otherwise flexibility's score and originality's score were low. When focus on thinking ability, all students' thinking were able to solve each questions. However, the standard deviation of the students has no difference for each type of thinking. Although, the some student has score of divergence, fluency, and flexibility was low, originality was equivalent student who has score of divergence, fluency, and flexibility was high. Because of the teacher emphasized the diversity idea and a new worth.

Conclusion

As this study investigated the students' creative thinking in the lesson study and the open approach contexts, the researcher studied the context and possibility for conducting the research by means of studying the operation of Kookham Pittayasan School, Sumsoong District, Khon Kaen Province in terms of the lesson study and the open approach, and students' Mathematical creativity. The results of the study revealed that the target school administered the instruction regarding the lesson study and the open approach continuously and regularly since 2006 to the present time under the monitor and supervision of the Center for Research in Mathematics Education, Faculty of Education, Khon Kaen University. Additionally, it provided the context for the teachers in the school to work together for developing the practical performances in teaching Mathematics and for sharing the methods of teaching Mathematics among the teachers, which led to the development of students' leaning in Mathematics.

The overall operation based on the process of the lesson study and the open approach of Kookham Pittayasan School during the period of ten years caused changes in the teachers, the students, and the cultures in the class. In other words, the learning atmosphere was flexible and the students were active in learning and assertive. Additionally, the students were encouraged to think differently and dealt with the problems or activities extensively without easily surrendering or giving up. Besides these changes, the students had positive attitudes towards working in groups or with others. The teachers could build the creative circumstances and encourage the students to percept their own abilities by providing the atmosphere that the students felt safe, dared to take a risk, and interacted with others. These were the crucial behaviors that encouraged the creativity according to the concepts of Nadjafikhah, Yaftian, and Bakhshalizadeh (2012).

After investigating the students' creative thinking in the lesson study and the open approach contexts, it was found that all of the students had used creative thinking consisting of divergence, fluency, flexibility, and originality in all items. The instructional management regarding the open approach encouraged the students to understand the learning topics by themselves through the activities of the open-ended problem situations. Besides the activities, the teachers employed the main and supplementary materials to encourage the students to figure out the meanings, the rules, and the formulas by themselves, which conformed with Hashimoto's concepts (1997), noting that the open approach was one of the methods that promoted mathematical creativity and played an immense role for the students to enable to collect the various methods of thinking about problem-solving. The mathematical creativity could be frequently found from collecting the different appearances of the classes and students.

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