Preservice Teacher's Pedagogical Content Knowledge in Lesson Study

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Abstract: *Pedagogical content knowledge (PCK) forms a knowledge base for teachers, guiding their decisions and actions in classrooms (Ball et al., 2008). Lesson study is processes for teacher professional development including collaboratively planning, doing and seeing (Inprasitha, 2010). This study was analysed preservice teacher's PCK in lesson study context. Data were collected by recording video tape and audio tape in classroom and were analysed by protocol analysis. The result revealed that; the first phase, preservice teacher and lesson study team created mathematics problem situations, flow of lessons, materials and anticipated students' ideas and difficulties. The second phase, preservice teacher collected, ordered and discussed students' ideas in classroom and then summarized the lesson through these ideas. Moreover, she decided to paused some ideas that quite difficult for others. And the third phase, preservice reflected to students' ideas and difficulties, sequences of lessons, materials and so on.*

Keywords: Pedagogical content knowledge, Lesson Study, Preservice teacher

Introduction

Most research supports the idea that teacher preparation is important, and that knowledge and skills are built over time in a coherent program of study. The National Council for Accreditation of Teacher Education suggests that a high quality of teacher preparation makes a difference in students' learning and helps preservice teachers acquire essential knowledge and skills (Inprasitha, 2015). Over the past several decades, teacher's knowledge has become a major topic of interest to teacher educators, researchers, and policy makers around the world (Shulman, 1986, 1987, Grossman, 1990; Fennema & Franke, 1992; Ball et al, 2008). The notion of pedagogical content knowledge (PCK) was proposed by Shulman (1986, 1987) as a new domain of teacher knowledge, and it has been a useful framework for exploring what teachers need to know and the development of content. Shulman conceptualized PCK as an integration of both the content and pedagogical knowledge.

All countries have faced the challenge of preparing teachers for the task of teaching mathematics (ICMI, 2004), and they have relied on their teacher education programs to ensure that preservice teachers gain the necessary knowledge and skills to be successful (National Council for Accreditation of Teacher Education cited in Inprasitha, 2006). Teacher educators should explore and survey the activities, tasks, and contexts in which the preservice teachers acquired their experience and their perceptions of teaching mathematics (Fernandez, 2005).

Some researchers have found that when lesson study was introduced as part of the teacher education program, preservice teachers were able to reflect and revise lessons by themselves (Hiebert & Stigler, 1999; Hiebert et al., 2007). One of the more recent developments of the teacher education program has been lesson study. Lesson study is a process used in Japan to develop the teaching profession and lessons within the context of students' learning and thinking by teacher-led instructional improvement cycle in which teachers work collaboratively to: formulate goals for student learning, plan a lesson, teach and/or observe the lesson, reflect on the gathered evidence, revise the lesson for improvement, and reteach the revised lesson (Inprasitha, 2015; Lewis, 2002; Fernandez & Yoshida, 2004). The integration of Lesson Study into the classroom also had an impact on preservice teachers' experiences as they participated in the research process which included such elements as the students' ideas, instructional materials, lessons, and reflection to improve teaching practice (Isoda, 2007). It has also shown benefits when used appropriately by preservice teachers (Chassels & Melville, 2009; Sims & Walsh, 2008).

Even though the 1999 Educational Act of Thailand called for educational reform, the mathematics teacher education programs of most universities in Thailand have not been able to

respond to this demand. Most school teachers still use a traditional teaching method that not only focused on content, to the detriment of students' learning processes, but also failed to realize that they are still trapped in a traditional paradigm (Inprasitha, 2015).

However, there is an initiative to use Lesson Study to improve the teacher education program in Thailand being implemented by the Faculty of Education, Khon Kaen University. This began as a project to investigate how preservice teachers develop their view of teaching, and to think critically about their role in the classroom, by using Lesson Study and understanding the impact it had on their learning experiences (Inprasitha, 2015). The underlying premise was that this study would provide opportunities for preservice teachers to improve their knowledge of teaching mathematics by examining their pedagogical content knowledge in a Lesson Study context.

Literature Reviews

Pedagogical Content Knowledge

Content knowledge is a necessary but not the only condition for good teaching. Mathematics teaching needs more than knowledge of content (Ball et al., 2005; Mewborn, 2001; Shulman, 1986). This is because teachers not only need to recognize that an answer is incorrect, analyses the source of any errors, and then work with the student to improve the mathematics, but they also need to choose appropriate examples and exercises in the correct sequence so that students are guided in their learning (Fennema & Franke, 1992).

Shulman (1986) defined the knowledge needed to cope with challenge of teaching into three categories: subject matter content knowledge, pedagogical knowledge and pedagogical content knowledge.

Franke & Fennema (1992) referred to PCK as teachers' knowledge of teaching procedures such as effective strategies for planning, classroom routines, behavior management techniques, classroom organization procedure, and motivation techniques.

An, Kulm & Wu (2004) point out the importance of pedagogical content knowledge has three components including knowledge of content, curriculum and teaching.

According to Shulman (1986), mathematical content knowledge and pedagogical content knowledge are integrated parts of effective mathematics instruction. In order to construct mathematical concepts in students' mind, pedagogical content knowledge as well as mathematical content knowledge is needed. The manner in which teacher relate their subject matter (what they know about what they teach) to their pedagogical knowledge (what they know about teaching) and how subject matter knowledge is a part of the process of pedagogical reasoning are seen as integrant of pedagogical content knowledge (Cochran, DeRuiter & King, 1993).

Ball, Thames, & Phelps (2008) broaden the Shulman definitions by proposing a model of mathematical knowledge for teaching by further dividing PCK into knowledge of curriculum, knowledge of content and students (KCS), and knowledge of content and teaching (KCT). KCS is knowledge that combines knowing about student and mathematics. This means that teachers must be able to anticipate students' difficulties and obstacles, hear and respond approach to students' thinking, and choose appropriate examples and representations while teaching. KCT is knowledge that combines knowing about mathematics and teaching. It refers to teachers' decisions on the sequencing of activities and exercises, their awareness of the possible their decisions to pause a classroom discussion for more clarification or to use student's opinion to make a mathematical remark.

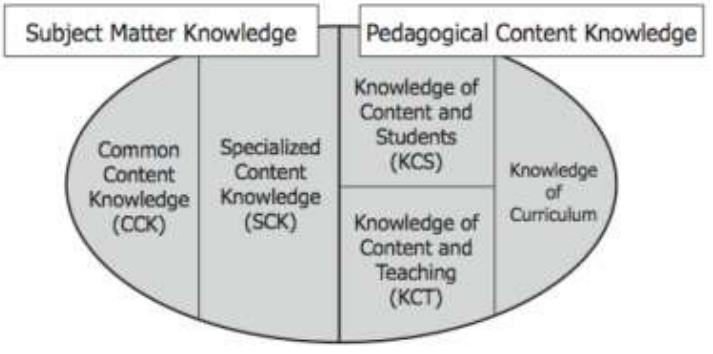

Figure 1 Mathematical knowledge for teaching (Ball et al., 2008)

Lesson Study

Lesson study is a set of comprehensive and well-articulated processes for examining the practices in which many Japanese teachers are engaged (Fernandez, Cannon & Chokshi, 2003 cited in Inprasitha, 2010). A teacher-led instructional improvement cycle in which teachers work collaboratively to: formulate goals for students' learning, plan a lesson, observe the lesson, reflect on the gathered evidence, revise the lesson for improvement, and reteach the revised lesson (Lewis, 2002; Fernandez, 2002).

Lesson Study consists of preparation, actual class and class review sessions in Japanese "kyozai kenkyu", "koukai/kenkyu jyugyo" and "jyugyo kentoukai" (Baba, 2007). Fernandez & Yoshida (2004) stated that Lesson Study processes including collaboratively planning, seeing the lesson, discussing the lesson, revising the lesson, teaching the new version of lesson and sharing reflection about the new version of the lesson.

However, in Thailand, it is not easy to implement Lesson Study in the school. Thus, instead of implementing Lesson Study directly it into three phases: collaborative design of a research lesson (Plan), the collaborative observation of the research lesson (Do) and collaborative discussion and reflection on the research lesson (See) (Inprasitha, 2010).

The "Plan" phase. This phase involved the researchers, school coordinator, co-researchers, participant teacher, preservice teacher, and the Lesson Study team, collaboratively designing a research lesson. During this phase, they chose mathematical activities using open-ended problems based on a Japanese mathematics textbook. The materials to be used in the classroom were also designed.

The "Do" phase. In this phase the Lesson Study team collaboratively observed the research lesson and implemented the lesson plan in the classroom with the teacher or preservice teacher as the teaching agent. Moreover, the classroom was observed by the researcher, co-researcher and school coordinator. They focused on not only the students' ideas, difficulties but also materials, flow of research lesson. They weren't focused on the teacher's competencies.

The "See" phase. Finally, the team collaboratively discussed and reflected on the research lesson then examined the findings of the teaching observation to improve the research lesson.

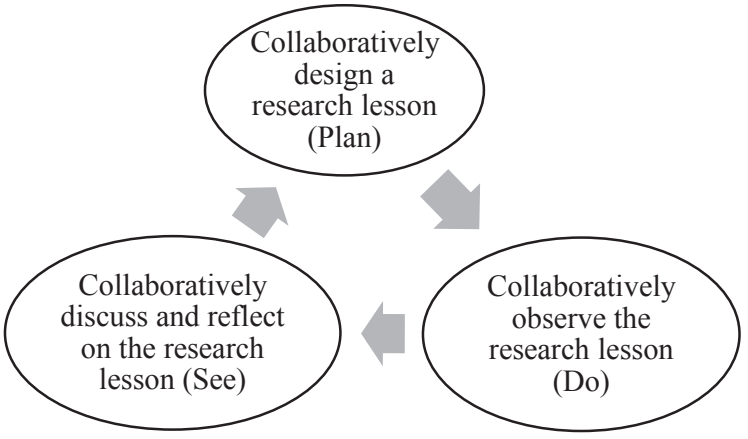

Figure 2 Adaptive Lesson Study in Thailand (Inprasitha, 2010)

Methodology

Research Design

In this study, which uses a qualitative research design, classroom action research, was undertaken to determine the pedagogical content knowledge of preservice teachers. Preservice teachers were observed, and at times worked with the author, for a period of six months using the lesson study processes as classroom action research: collaborative planning, doing and seeing, we work together more than six months

Target group

The target of this study was selected from preservice teachers who were enrolled in a fifth-year mathematics teacher preparation program in Mathematics Education, Faculty of Education, Khon Kaen University, Thailand. She not only learned about school mathematics courses, such as number and

operation in school mathematics, and algebra in school mathematics, but also learned mathematical learning processes courses, such as problem solving in school mathematics, communication in school mathematics and so on. Moreover, she participated in extra activities, such as the APEC-Lesson Study international conference, workshops on how to use mathematical problem solving textbooks, and a teaching approach which focused on problem solving.

During this time, she undertook her practicum I and II courses at a research project school, Kookum Pittayasan, which has been using lesson study since 2006. This school participated in the "Project of Research and Development for Teacher Mathematics through Lesson Study and Open Approach" launched by the Center for Research in Mathematics Education, Khon Kaen University, Thailand.

Data Collection

The data of this study was collected during the preservice teacher's 'School Practicum I' course. Following the lesson study processes, the first phase being collaboratively plan, the lesson study team designed the lessons and materials. For the second phase, collaboratively do, the preservice teacher as the teaching agent, taught the students and others observed and collected the students' ideas, difficulties, sequence of lesson, and so on. Finally, for the third phase, collaboratively see, the lesson study team reflected and discussed the events in the classroom. During every phase, the lesson study processes and the interviews that followed, were recorded on video and audio.

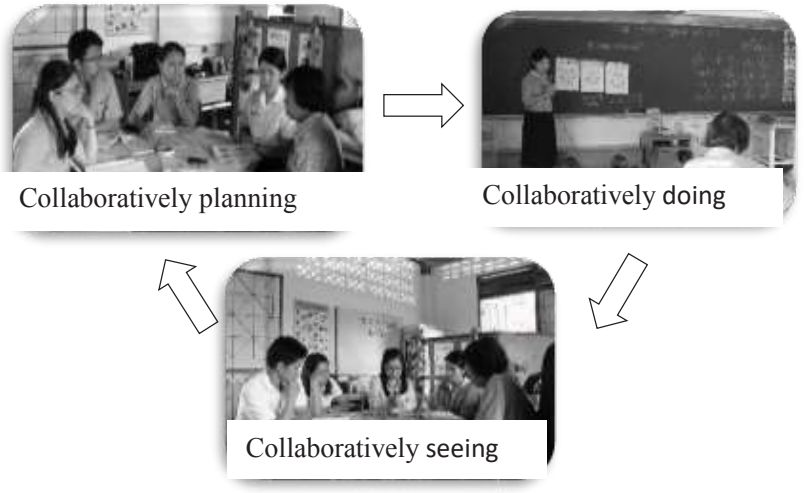

Figure 3 Data collection following Lesson Study processes (Inprasitha, 2010).

Data Analysis

The data from the following sources including (a) transcripts from video- and audio-recorded planning sessions, (b) lesson plans, (c) transcripts from video- and audio-record observing sessions, and (d) transcript from video- and audio-recorded reflecting session. The data were analysed by means protocol analysis and analytic description for examine preservice teacher's PCK in Lesson Study context through three stages consisting of transcribing and verifying all records collected during planning, observing and reflecting sessions and explaining by analytical descriptive based on Ball et al.'s ideas (2008).

Results

This example showed PCK in lesson study processes. The lesson is videotaped and analyzed using the video recording and the transcript according to Lesson Study processes.

PCK in Collaboratively planning

The goal of the lessons was students to be able to understand a subtraction in sense take away. The first task (figure 3) required students to describe the stories.

Figure 3 Task 1 Let's talk about this picture.

The second task, "How many remains?" (figure 4) was designed for students to be able to write a mathematical sentence and solve problem.

Figure 5 Task 2 "How many remains?"

The lesson plan designed by the lesson study team; preservice teacher (PT), in-service teacher (T), researcher (R) and co-researchers (CR1, CR2). During initial planning the lesson, the first task (Figures 3), they discussed about flow of lesson and design materials for this lesson.

Item65 (R1): What are the steps in this lesson?
Item66 (T): Tomorrow, will we use paper as materials?
Item67 (PT): Yes.
Item68 (T): Um. Use paper.
Item69 (PT): I think that I will present these pictures. (point the pictures in textbook)
Item70 (T): Step by step.
Item71 (PT): Yes, and then I will present these pictures.
Item72 (T): What do you see? Tell story. How many?
Item73 (PT): OK.

From Item 65-73 the preservice teacher presented the flow of the lesson, Firstly, show the pictures (Item 69) and then asked the students to tell stories of subtraction (Item 71). Meanwhile, the in-service teacher suggested questions to ask the student (Item 72). From the viewpoint of PCK, knowledge of teaching and mathematics, this dialog demonstrated the preservice teacher's decision about the sequence of teaching and that she accepted the in-service teacher's suggestion.

For the second task, they anticipated students' responses from figure 4 (see following dialog).

Item93 (CR2): They may don't know that how many cakes in a dish.
Item94 (T): Yes.
Item95 (CR2): Eat all or…
Item96 (PT): But…
Item97 (CR1): It's look like…
Item98 (PT): Maybe eat two pieces of cakes.
Item99 (T): But it is full dish so it has four pieces certainly because it is full. Look at the dish it's impossible that seen cake have five pieces.
Item100 (CR2): It's quite big cake.

Item101 (T): If we haven't story. Oh?

Item102 (PT): The pupils may think that child eat all.

Item103(T): If he eats all. He may have a stomachache. (laugh)

From Item93-103 lesson study team anticipated students' response to the second task. Preservice teacher tried to anticipated of students' response to problem situation (Figures 4) (e.g. Item 98 and 102). From the viewpoint of PCK, knowledge of students and mathematics, this dialogues showed that preservice teacher's anticipated student's ideas.

Moreover, preservice teacher tried to anticipated students' difficulty to this problem situation follow these dialogs.

Item122 (T): But...when students read this text…and then…they may agree with.

Item123 (Others): Yes.

Item124 (T): Students can write mathematics sentence because today they learned it already.

Item125 (PT): Yes. They may think that subtract or add but they eat…eat…it's look like take away.

Item126 (T): I agree with you. Students may tell us that it's similarly take away.

Item127 (Others): Yes.

Item128 (T): Eat is look like take away, right?

Item129 (Others): Yes. It's similarity.

From this conversation, they discussed about students' obstacles. They talked about how the students could write mathematical sentences in subtraction or addition. Because the students had learned addition but this was the first time they had learned subtraction, they might be confused between the two. Furthermore, Item 122-130 showed that the preservice teacher and team had anticipated the students' obstacles from the lesson. From the viewpoint of PCK, this dialog showed knowledge about students and mathematics.

After that, they talked about what materials to design and employ that would help to promote discussion as well as extend and summarize students' ideas. In task 2 they chose blocks to extend the students' ideas about subtraction in the sense of 'take away'.

Item718 (R): Do students write blocks?

Item719 (PT): Yes.

Item720 (R): Last time we used block on blackboard. Now we shall design worksheet about block's action.

Item721 (CR1): Um. Do students present their ideas?

Item722 (CR2): I agree with you.

Item723 (PT): Um. I think that I would like to use blocks in first steps (introduction) and review learning how to learn of students.

Item724 (R): Um.

Item725 (PT): And then I will use work sheet and blocks for discuss and extend students' ideas on the blackboard.

Item726 (Others): OK.

For Items 718-726, the Lesson Study team designed worksheets and materials to use in the lesson. The student worksheets were for writing and describing their ideas, and the blocks were used for extending and summarizing students' ideas on the blackboard, as proposed by the preservice teacher in items 723 and 725. Thus, from the viewpoint of PCK, it demonstrates material design as knowledge of curriculum.

PCK in Collaboratively Doing

In this phase, the Lesson Study team implemented the lesson in the classroom. The preservice teacher was the teaching agent and others observed the lesson. The preservice teacher followed the Open Approach and included the four steps; posing open-ended problem, students' self-learning, discussion and comparison students' ideas and summarizing through connection students' ideas (Inprasitha, 2010).

In the second task, the preservice teacher presented the pictures on the blackboard and asked students to guess. As follows:

Item53 (PT): Do you see this pictures? What is this?

Item54 (St3): Wow. It's interesting!

Item55 (PT): What do you see?

Item56 (St): Cakes, 4 pieces.
Item57 (PT): What?
Item58 (St): Cakes and 4 pieces.
Item59 (St3): And a dish.
Item60 (PT): Really?
Item61 (St): Yes.
Item62 (St4): A box…and cakes.
Item63 (PT): OK, and then? What does he do?
Item64 (St): He ladle cake into a dish.
Item65 (PT): Um. How many?
Item66 (St3): One.
Item64 (ST): Two.

From Item 53-64 demonstrates that the preservice teacher asked students as per her questions "What do you see?" (Item55) "Really?" (Item60) and "What does he do?" (Item63).
For creating the problem solving classroom, she tried to maintain the students' curiosity so that they accept the problem as their problem. In this situation, we call students' problematic. From the viewpoint of PCK, this shows knowledge of teaching and mathematics.

After they talked about the pictures. The preservice teacher posed an open-ended problem to keep the students curious. Following these dialogs:

Item 103 (PT): Please tell me about this pictures. How many pieces of cake that he has?
Item 104 (Sts): 4 pieces
Item 105 (PT): And what does he do?
Item 106 (Sts): He eats a piece of cake.
Item 107 (PT): What do you think that I will ask you?
Item 108 (St1): I don't know.
Item 109 (PT): What do you think that I will ask you? He has some cakes and eats a piece of cake.
Item 110 (St2): How many some cakes remains?
Item 111 (PT): Ah. How many remains? How do you write mathematics sentence?
Item 112 (St1): Me.
Item 113 (St2): Me.
Item 114 (PT): Oh, next time. I would like to ask you find how many some cakes remains and then write mathematics sentence.

These conversations that preservice teacher kept students' curiosity all time. Students' curiosities were key points for problem solving classroom as item 107 and 111. Therefore, from viewpoint of PCK, that is knowledge of teaching and students.

After the preservice teacher posed the problem, the students solved the problem by themselves and then they presented their ideas to peers and teacher.

Item403 (PT): Who have difference ideas?
Item404 (St): Me.
Item405 (PT): OK. What do you want to increase describe?
Item406 (St): I think its look like addition.
Item407 (PT): Um. What?
Item408 (St): It's one, is four, and three added. Um three add one (3+1) and four minus one (4-1) is three.
Item409 (PT): Three plus one and minus…
Item410 (St): It's three plus one and four minus one.
Item411 (PT): Do you understand? (Asked all students.)
Item412 (St): (Quiet)
Item413 (PT): Oh, Thank you for your idea. We can talk next time.

This episode showed that the preservice teacher decided to pause this idea because many students were unable to understood. Thus, this dialog reflects the idea of knowledge about students, teaching and mathematics.

PCK in Collaboratively Seeing

In this phase, the Lesson Study team reflected about the events in the classroom. They collected data such as students' ideas and difficulties, materials, and student responses to task and teaching sequences. The order of reflection was preservice teacher, teacher, co-researchers, researcher and preservice teacher again, respectively.

Item 1 (PT): For second task, I tried to invited Poogun to present her ideas. She presented 5-3=2 similar 3+2=5 so I asked her to described it. She explained that it looked like the movement such as 5-3=2 and 3+2 =5. She adhered to using the arrows to represented the narrow of addition and subtraction. So, she saw the relationship between addition and subtraction.

From her reflection, it revealed that she observed students' ideas, especially Poogun's, and she was aware that this this idea could be extended to others. From the viewpoint of PCK, this showed the knowledge of teaching and mathematics.

Item 1 (PT): For the second task the students were confused when they saw figure 4. They could not realize the problem because they misunderstood and thought that it was addition.

This reflection shows that she realized the problems with the materials and the connection to students' difficulties. From the viewpoint of PCK, she could demonstrate her knowledge of both the curriculum and the students understanding of the mathematics involved.

What followed was the teacher and researchers gave their feedback and opinions then finally the preservice teacher responded to their input as follows;

Item 8 (PT): From others' opinions made me realized about my teaching. When I more followed Poogun's ideas and unattended other students it looks like I abandoned these students although the final of teaching episodes I have turned to my goal in this lesson. I will have noted this phenomenon in the lesson plan. I hoped that it helped other people learned this issue and had the way solved this problem.

From her reflection, it can be seen that she understood the problems that related to her teaching sequence and vowed to revise her teaching for the next time. From the viewpoint of PCK, that is knowledge of teaching and students.

Conclusion and Discussion

Conclusion

This study focused on preservice teachers' PCK in lesson study context in 3 phases. The first phase, collaboratively plan, preservice teacher's PCK including knowledge of students and mathematics, knowledge of teaching and mathematics and knowledge of curriculum. The second phase, collaboratively do, preservice teacher's PCK including, knowledge of students and mathematics, knowledge of teaching and mathematics. And the third phase, collaboratively see, preservice teacher's PCK including knowledge of students and mathematics, knowledge of teaching and mathematics and knowledge of curriculum.

Discussion

The results of this study indicated that the Lesson Study context created more opportunity among preservice teachers to improve, by taking active part in observation, and using data (students' works and observations) to make informed choices about how to create improved learning for their pupils, as Munthe, Bjuland & Helgevold (2016) revealed that lesson study informs about how to improve students' learning for preservice teachers. Moreover, the results showed an increase in pedagogical content knowledge with the lesson task by making mathematical and real world connections in addition to promoting students' interest. For instance, preservice teacher chose real world object such as instructional material, mathematical tasks, sequences of lesson and anticipated student's responses.

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