กรณีศึกษาเชิงวิพากษ์วิจารณ์: ครูวิทยาศาสตร์ไทยระดับประถมศึกษาพัฒนาความเข้าใจและการปฏิบัติการสอนด้านการกำหนดเป้าหมายการจัดการเรียนรู้วิทยาศาสตร์อย่างไรเมื่อเข้าร่วมในรูปแบบการร่วมมือกันในการสอน

Interpretive Case Studies: How did three Thai In-service Science Teachers Develop their Understandings and Practices of Articulating the Purposes for Teaching and Learning Science through a Co-Teaching model?

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Abstract

Thai education was enhanced by globalization and should realize the importance of scientific concepts and the process of acquiring knowledge in order to achieve scientific and technology goals. The science curriculum, the teaching and learning process, the assessment of student outcomes, and science teacher training need to be changed. National science education standard has also been formulated to help Thai people attain scientific literacy. The teachers are accepted as the main factors that set the direction of Thai educational reform for developing teachers' careers. Pedagogical Content Knowledge [PCK] is ary essential component for teacher education. The research purpose is to enhance Thai science teachers' PCK through a Co-Teaching Model [CTM]. Development of understandings and practices of articulating the purposes for Teaching and Learning is an important aspect of PCK. Three volunteer science teachers in grade 4-6 at the same school participated in this study for 1 year. A CTM was used as a professional development [PD] program. The data consisted of classroom observations, individual interviews, questionnaires and document analysis. Inductive analysis was used to analyze the data into more general outcomes in which were presented in three case studies and a cross-case analysis. Findings indicated that CTM enhanced Thai science teachers to develop their constructivist teaching styles. Their designs of inquiry-based lesson plans and their classroom practices shifted from teacher-centered to

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student-centered teaching and learning practices gradually. The sustained production of inquiry-based lesson plans and practices demonstrated that teachers gradually accepted the CTM as method of PCK development. Further research is needed to understand how schools and district administrators can promote effective PD program for elementary science teachers.

Keywords: Pedagogical Content Knowledge, A Co-Teaching Model, Constructivist Teaching and Learning, Inquiry Approach, Professional Development

บทคัดย่อ

การพัฒนาด้านโลกาภิวัตน์ส่งเสริมให้ระบบการศึกษาไทยหันกลับมาตระหนักถึงความสำคัญของการส่งเสริมความเข้าใจแนวคิดทางวิทยาศาสตร์และกระบวนการของการแสวงหาความรู้ทางวิทยาศาสตร์เพื่อให้บรรลุเป้าหมายทางด้านวิทยาศาสตร์และเทคโนโลยีดังนั้น หลักสูตรวิทยาศาสตร์ กระบวนการจัดการเรียนรู้ การวัดและประเมินผลการเรียนรู้ของนักเรียน และการรูปแบบการจัดโครงการพัฒนาวิชาชีพครูจำเป็นต้องมีการปรับเปลี่ยนเพื่อให้ตอบรับต่อความต้องการของครูวิทยาศาสตร์และสอดคล้องต่อปัญหาในปัจจุบัน การสร้างและพัฒนากรอบหลักสูตรวิทยาศาสตร์ใหม่เพื่อช่วยให้คนไทยเป็นผู้ที่รู้วิทยาศาสตร์ ครูวิทยาศาสตร์ถือว่าเป็นปัจจัยหลักที่สามารถกำหนดทิศทางของการปฏิรูปการศึกษาไทยได้ สำหรับวิชาชีพครูวิทยาศาสตร์นั้น การส่งเสริมให้ครูวิทยาศาสตร์มีองค์ความรู้ด้านความรู้เนื้อหาผนวกวิธีสอน(Pedagogical Content Knowledge) [PCK] ที่เหมาะสมนั้นเป็นแนวทางสำคัญต่อการพัฒนาคุณภาพการจัดการเรียนรู้ ดังนั้นวัตถุประสงค์ของการวิจัยนี้ คือส่งเสริมให้ครูวิทยาศาสตร์มีความรู้เนื้อหาผนวกวิธีสอนผ่านรูปแบบการร่วมมือกันในการสอน(Co-teaching Model) [CTM] ในโดยการศึกษาครั้งนี้มุ่งเน้นเพื่อการพัฒนาความเข้าใจและการปฏิบัติการสอนของครูวิทยาศาสตร์เกี่ยวกับการตั้งเป้าหมายหรือวัตถุประสงค์ในการจัดการเรียนรู้ ซึ่งถือว่าเป็นองค์ประกอบที่สำคัญในความรู้เนื้อหาผนวกวิธีสอน โดยกลุ่มวิจัยในครั้งนี้คือครูวิทยาศาสตร์ที่เป็นอาสาสมัครระดับชั้นประถมศึกษาปีที่ 4-6 ในโรงเรียนเดียวกัน ครูวิทยาศาสตร์ทั้ง 3 ท่านเข้าร่วมในการศึกษาครั้งนี้เป็นเวลา 1 ปี เครื่องมือสำหรับการเก็บข้อมูล ได้แก่ แบบสังเกตการจัดการเรียนรู้ แบบสัมภาษณ์กึ่งโครงสร้างและการใช้สถานการณ์จำลอง แบบสอบถามปลายเปิด โดยเน้นการวิเคราะห์เอกสารและการวิเคราะห์เชิงเนื้อหา ข้อมูลวิจัยนำเสนอในรูปแบบของกรณีศึกษา

ผลการวิจัยแสดงให้เห็นว่ารูปแบบการร่วมมือกันในการสอนสามารถส่งเสริมความรู้ผนวกวิธีสอนของครูวิทยาศาสตร์โดยศึกษาจากได้จากการพัฒนาแผนการจัดการเรียนรู้และการการปฏิบัติการสอนในชั้นเรียนที่มีแนวโน้มเปลี่ยนแปลงจากครูเป็นศูนย์กลางสู่กิจกรรมการจัดการเรียนรู้ที่เน้นนักเรียนเป็นศูนย์กลาง ซึ่งการพัฒนาการปฏิบัติการสอนนั้นค่อยๆ ปรับเปลี่ยนไปในทิศทางที่ยั่งยืน ข้อเสนอแนะสำหรับการวิจัยต่อไปคือ ควรมีการศึกษาถึงปัจจัยสนับสนุนจากผู้บริหารโรงเรียนและเขตพื้นที่การศึกษาต่อผลสำเร็จของโครงการพัฒนาวิชาชีพครูสำหรับครูวิทยาศาสตร์ระดับประถมศึกษา

คำสำคัญ: ความรู้เนื้อหาผนวกวิธีสอน, รูปแบบการร่วมมือกันในการสอน, การจัดการเรียนรู้ตามแนวคอนสตรัคติวิซึม การเรียนรู้แบบสืบเสาะ, การพัฒนาวิชาชีพครู

Introduction

In the process of developing competent Thai citizens, teachers play an important role in educational reform and science education (ONEC, 2001; Pongsopon, 2003; Pitiyanuwat, 2004; Roadrangka, 2004). In Thailand, teachers are widely accepted as the heart of the learning reform because they are the most significant and indispensable component in the teaching and learning processes occurring in classrooms Teachers additionally play an important role in facilitating learning and development of students who are regarded as an indicator of success in economy, society, politics, education, culture, science and technology development (Pornsrima, 2002) and an important resource of the nation in the future (Secretariat of the Teacher Council, 1994).

The national requirements for teacher preparation and development seek to encourage teachers to organize the learning process. The success of educational reform depends on the quality of teachers and their cooperation (Jurawatanaton, 2003). Nevertheless, the quality of in-service teachers has regressed considerably in recent years (Sinlarat, 1999). Thailand attaches great importance to improving the status and quality of teachers and education personnel. The teacher acts as a facilitator who provides students with activities to change them from any alternative conceptions to scientific conceptions. The facilitator also has roles in: discovering what the students are thinking; helping students to clarify and to reflect on their own ideas; challenging student's ideas; developing school–based science curriculum, planning lessons, developing instructional media; and assessing and evaluating student learning, and so on. The role of the teacher as facilitator and the learner-centered approach, based on constructivist-based teaching and learning perspectives, will contribute to the success of learning reform in Thailand (OEC, 2004). According to Pillay (2002) and Narot (2004), Thai teachers less an understanding of the concept, principles, and processes involved in these new approaches of teaching and learning and also have negative attitudes towards the new methods. This means that teachers need to gain knowledge of such teaching and learning methods and believe in them. According to research by Pruet Siribanpitak (2004), many teachers do not have qualifications that match the subjects they teach, and out-of-field teaching adds to the difficulties in critical subjects. Teachers have difficulties in implementing constructivist-based teaching and learning approaches. These approaches are seen to be radically new for the majority of science teachers and they are suspicious of their effectiveness. Particularly, there are a number of studies that document the current Thai education system has problems with in-service elementary science teachers (ONEC, 2001; Yutakom and Chaiso, 1999). Thai elementary school teachers often have not enough pedagogical content knowledge necessary to create a constructivist classroom. Moreover, most in-service science teachers did not graduate in science (ONEC, 2001). The data from the Office of National Primary Education (1994) pointed out that only 7.7 percent of all teachers graduated in science (ONEC, 2001). This causes them to be weak in

science content and skills, with a resulting lack in confidence and competence when teaching science. Elementary science teachers with low confidence cope by only teaching the minimum required and stressing aspects in which they feel more confident. For example, they may use prescriptive texts, underplay questioning and discussion, and perform only simple practical work with basic equipment. When these coping strategies become the norm, pupils' academic attainment is limited (Osborne and Simon, 1996). Most importantly, they lack an understanding about how to represent science content in ways that are personally meaningful and potentially accessible to students; in other words, they lack pedagogical content knowledge [PCK] (Tobin and McRobbie, 1999; Raizen and Michelsohn, 1994 cited in Kelly, 2000). In Thai education an inquiry approach is the main strategy for teaching science following constructivist approaches. The National Science Education Reform advocates that science teachers should engage students in doing and thinking about inquiry, and renew emphasis on teaching about the nature of science (Institute for Promotion of Teaching Science and Technology [IPST], 2002b). Most in-service science teachers have a vague meaning of scientific inquiry in the classroom that has taken on different forms; while researchers and teacher educators may have very different views and practices (Crawford, 2000). These are some of the reasons as to why science teachers cannot shift toward more learner-centered and more inquiry-centered K-12 classrooms. Therefore, the main factor that supports creating a more 'learner-centered classroom environment is the teacher's pedagogical content knowledge. A review of state policy evidence. In particular, this issue can be related to the Thai context since recent low achievement in science was evidenced in every subject in Thailand's National Test, taken by students at the end of grades 3, 6, 9 and 12. In order to provide students with opportunities and activities to learn science in line with these educational reform guidelines, it is suggested that science teachers use the teaching approach associated with student-centered learning (OEC, 2004).

Research Questions and Research Objectives

The study examines the enhancement of elementary science in-service teachers' pedagogical content knowledge [PCK] through the co-teaching model [CTM]. For this research journal will reports on only important component of PCK. Knowledge of articulating goals for teaching and learning science is realized to be the influence factor that can determine teachers' practices in their classrooms. The research objectives are expressed through the following research questions.

Research Question

1. What are some of the characteristics of the PCK developed by elementary science teachers when engaging with the CTM?

2. Do any changes occur in the teachers' understandings and practices of articulating the purposes for teaching and learning science?

Research Objectives

This research aims to examine the development of elementary science teachers' pedagogical content knowledge when engaging in a co-teaching model.

Research Methodology

Interpretivism as a Theoretical Framework

From an interpretivist point of view, what distinguishes human (social) action from the movement of physical objects is that the former is inherently meaningful. Thus, to understand a particular social action, the inquirer must grasp the meaning that constitutes that action. To say that human action is meaningful is to claim either that it has a certain intentional content that indicates the kind of action it is or that what an action means can be grasped only in terms of the system of meanings to which it belongs. To find meaning in a human action or to understand what a particular action means requires that one interpret in a particular way what the actors are doing. Dilthey (1958) argued that to understand the meaning of human action requires grasping the subjective consciousness or intent of the actor from the inside. This interpretivist stance is explained in Collingwood's (1946, 1961) account of what constitutes historical knowledge, and it lies at the heart of what is known as objectivist or conservative hermeneutics. Major lenses for studying this context have been provided by a number of research approaches. The necessity of understanding people's contextual realities before introducing changes in the hope of improving the quality of education in any context is well summarized by Fullan (1982).

The study reported in this research is aimed at identifying how a PCK-based science co-teaching model impacts on the development of in-service elementary science teachers' PCK, and how they develop their PCK during a co-teaching model. The researcher views educational environments such as classrooms, CTM, and schools as a complex world. The elementary science teachers in these educational environments are persons who construct their own knowledge and interpret the meaning of the social world to develop their PCK. The researcher thus believes that an interpretive methodology can provide appropriate directions to conduct the research in order to reach the answers to the research questions. Interpretivism is therefore employed as a framework to find out the meaning of how elementary in-service teachers learn and construct their own PCK in specific contexts. A variety of research methods such as observations, interviews, and document review were used to provide the complex and holistic view of what teachers know, how teachers act, and why they do so.

Context of the Study

This study was conducted in a elementary school governed by the Office of the basic education commission. The school is located in Nontaburi province in suburban area of Bangkok Metropolitan. The school has two semesters per year; the first semester ran from May to September and the second semester ran from November to March. The school breaks each academic year for the month of

October. The three case studies were teachers at Wattanawan School. The school enrolls students from kindergarten to grade 6. However, the study focused only on science elementary teachers who taught at higher primary level which involved students in the 4^{th} – 6^{th} grades. Therefore, the participants in this study were three elementary science teachers who were teaching at the upper elementary level (Level Standard 2, grades 4-6) in public schools under Office of the Basic Education Commission. They were purposive sampling selected from thirty-three teachers who completed questionnaires during the second semester of the 2009 academic year. Three elementary in-service teachers completed a questionnaire and were interviewed to collect data and in how they worked their school situations. They came from diverse backgrounds and academic training from their graduating universities. To protect their privacy they were given pseudonyms, Ms. Malai, Ms. Napaporn, and Mr. Sirod. In the first semester of the 2009 academic year, these elementary science teachers were provided with the co-teaching model which was developed to become the PCK based co-teaching model of this research. In order to develop the teachers' understandings and practices of PCK through CTM, multiple data sources have been used during the research process.

Research Participants

Purposeful sampling is brought to find the research sample as selection strategy. This sampling method is based on the criteria that the researcher would like to learn and find the answer for research questions. The participating science teacher indicated their willingness to participate in the study. In the end three criteria were used for choosing the participants and they were as follows:

a) Teachers who were teaching Science subject in the upper elementary levels in the same school. They were science teachers in grade 4, 5 and 6.

b) The teachers were teaching Science in both semesters and could participate in both phase of the study.

c) They showed a willingness to contribute to the profession by being open to classroom observations by the researcher, participate in follow-up interviews and be able to attend meeting of the PCK based co-teaching model.

Subsequently, the researcher visited teachers in school and had conversations with the school administrators regarding the study plan. Therefore, the participants in this study were three elementary science teachers who were teaching at the upper elementary level (Level Standard 2, grades 4-6) in public schools under Office of the Basic Education Commission. They were purposive sampling selected from thirty-three teachers who completed questionnaires during the second semester of the 2009 academic year. Three elementary in-service teachers completed a questionnaire and were interviewed to collect data and in how they worked their school situations. They came from diverse backgrounds and academically training in their universities. To protect their privacy they were given pseudonyms, Ms. Malai, Ms. Napaporn, and Mr. Sirod. In the first semester of the 2009 academic year, these el-

ementary science teachers were provided with the co-teaching model which was developed to become the PCK based co-teaching model of this research. The following section and Table 1 describes the teachers' education backgrounds and their situations.

Teachers' Background

Case Study I: Ms. Malai

Ms. Malai, who was 50 years of age at the time of the study, has a Bachelor's degree of Social education. She had been teaching Social subject for 24 years. Since 2006, she has been teaching in Science subject for 3 years. There were 35 students per classroom. She taught in Science subject for 12 hours to 15 hours per week. In addition to teaching in classroom, she had the reasonability to do school accounting and consulter for 4th grade students. For school curriculum, she only selects books and makes lesson plans that are taught following the school curriculum. She had responsibility of teaching science in grade 4 and she volunteered to do even though she did not have strong background in Science. It is for reason that she attended several workshops and took CTM related to the area of Science during school holidays.

The workshops and CTM covered theoretical knowledge related to Science for grade 4 as well as provided her with opportunities for practical field experiences. During 5 years, the following is a list of some of the Promotion of Teaching Science and Technology, IPST; the Department of Education, Faculty of Education, Kasetsart University; and Educational Districts. The many workshops she attended covered topics such as: making teaching and learning material, making teaching and learning assessment, designing lesson plan, using teaching strategies and knowledge directly related to the field of Science. Even though she attended many workshops, she still cannot be confident to teach science.

Case II: Ms. Napaporn

Ms. Napaporn was 53 years old; she graduated with a degree of physical education. She has 11 years of teaching experience in science subject. In previous years she taught science in the lower primary levels. For the past ten year, she has been teaching in 5th grade in Science subjects. There were 40 students per classroom. She has to teach in science subject for 12 hours per week. She taught this subject area even though it is not her area of expertise. In addition to teaching in classroom, the teacher has many responsibilities to do such as student's consulter for 5th grade students, laboratory teacher, activity teacher, scout teacher and the head of the Science department. In 5 years, teacher A has been attended with many workshops provided by educational institutions and her school. These workshops focus on curriculum, lesson plan, instructional media, teaching method, and learning and teaching assessment. She also participated to create school curriculum including selecting manual books.

Case III: Mr. Sirod

Mr. Sirod was 38 years in-service elementary teacher. He graduated with a degree of Agricultural education. In 10 years previous he taught Agricultural Subject in the lower primary levels. For 1 year and 11 months, he has

been teaching in grade 6 for Science subject. There were 40 students per classroom. He had to teach in science subject for 12 hours per week. He taught this subject area even though it is not his area of expertise. More than teaching in classroom, the teacher had many responsibilities to do such as consulter section for 6th grade students, laboratory section, audio-visual section and students' activities section in this school. In 5 years, he has been attended with many workshops provided by educational institutions and his school. These workshops and CTM covered theoretical knowledge related to curriculum, lesson plan, instructional media, teaching method, science content, and learning and teaching assessment. For school curriculum, he only selected books that are taught following the school curriculum.

Research Design

The design of the research reported here is divided into two main phases according to the research objectives. The first phase describes data collection and analysis and investigates the impact of the PCK based co-teaching model on teachers' PCK development. The second phase describes data collection and analysis, and strategies enhancing trustworthiness and it attempt to understand how science elementary teachers develop their PCK during the co-teaching model. This research composes of 4 phases which include: CTM I: Exploration (July-September 2009), CTM II: Preparation (October-November 2009), CTM III: Co-Planning (December 2009), and CTM IV: Co-Teaching and –Evaluating (January-February 2010).

Research Data Analysis

In the data analysis methods, the researcher attempted to find out patterns of growth or development by comparing the in-service teachers' understandings and practices of PCK through CTM, The approach to analysis involved an inductive process: categorical aggregation and a search for correspondence and patterns. Because this study employed a multiple case research design, the data analysis methods began with within-case analysis and followed by cross-case analysis. Triangulation was used to describe the idea that the researcher tried to construct an explanation by using more than one or multiple source of data.

Research Results and Conclusion

The data sources included individual interviews, card sorting, classroom observations, inquiry-based lesson plans, written reflections, and central meetings. The data was collected during the last three phases of the CTM [CTM II-IV]. As the CTM progressed, the result from cross case analysis revealed that the three teachers' PCK gradually progressed through the learning activities in the CTM. The teachers were provided with many opportunities to broaden their understanding and practices about the nature, teaching and learning of science. They had a chance to express their initial understandings and compare their understandings to constructivist understandings of teaching and learning science, proposed in the Basic Education Curriculum, and the Science Curriculum Framework. In co-planning, co-teaching, and co-evaluating stages, the teachers worked

with colleagues collaboratively. They increasingly integrated their understanding and practice of PCK in aspects of subject matter knowledge, pedagogical knowledge, and knowledge of context through sharing, reflecting, and discussion during their co-planning, co-teaching, and co-evaluating. Through these activities, the teachers' understanding and practices of PCK supported teaching and learning science based on constructivism shifted to more constructivist understandings specifically, in the nature of scientific knowledge. In particular, the teachers' understandings and practices after participating in the CTM reflected a shift toward a more learner-directed type of inquiry. The three teachers held full understandings and practices about student-directed inquiry in terms of the teaching strategy: lesson introduction, investigation, conclusion/explanation, communication, and group working. As the CTM progressed, the three teachers gradually accepted their multiple roles and the student's role as an active and minds-on investigator. They realized that they needed to emphasize in their inquiry-based lessons the three elements of scientific knowledge, science process skills, and scientific attitudes as goals and purposes for teaching science. With regard to instructional process, the teachers' understandings and practices moved forward mainly from the notions of structured inquiry and guided inquiry to open inquiry (Colburn, 2000: DCID, 2002).. After CTM II-IV, Malai, Napaporn, and Sirod changed their understanding of PCK in that they became more confident in their science knowledge, integrating guided and open inquiry approach, and utilized school and community contexts for lesson development. In the co-teaching stage, the results from three cross case analysis indicated that their practices became more aligned with their understanding. With regard to the instructional process, their students were encouraged to think, do Hand-on activity, be challenged to apply science knowledge into their daily lives. All of the teachers focused their inquiry-based lessons on scientific knowledge, science process skills, and scientific attitudes consistent with the NSCS. At the end of their lessons, the three teachers incessantly connected new knowledge with students' prior knowledge. CTM provided experience for Malai, Napaporn, and Sirod to work together in planning, teaching, and evaluating. The process of sharing, discussing, and reflecting about their understanding and practice of PCK awakened the three teachers to move on their understanding and practice of PCK to be consistent with learner-centered approach. Developing science knowledge, pedagogical knowledge, and knowledge of content of three teachers was gradually developing along with CTM proceeding.

Implications and Recommendations for Further Study

The results of this study indicate that participation in CTM was a successful strategy for promoting changes in science teachers' understandings and practices of PCK from a teacher-directed to learner-directed set of instructional practices. They were at the end of the project able to integrate all aspects of knowledge or PCK in their practices. However, the study did not investigate the process that individual teachers used to change their under-

standing and practice of PCK. Thus, this study suggests that there is value in future research, particularly in a Thai context, to study how science teachers learn to change their understandings and practices of PCK in the context of a professional development model similar with the CTM. There is also the need for future study to investigate how science teachers maintain their new understandings and practices of PCK during or after they leave the professional development program.

For readers and researchers who are interested in doing similar studies, it is important to remember that this study was conducted with a group of three science teachers who taught at the elementary level in the same school. The findings from this study were not intended to generalize to all science teachers. Nevertheless, the description of how the CTM approach to professional development was implemented and the context surrounding the use of this approach may be useful to others who decide to use this as model for teacher professional development in their own context.

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