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In-Service Science Teachers' Pedagogical Content Knowledge

Prasart Nuangchalerm[1,*]

[1]Department of Curriculum and Instruction, Faculty of Education, Mahasarakham University, Mahasarakham, 44000, Thailand
[*]Corresponding author.
Email: prasart.n@msu.ac.th

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Abstract
The concept of pedagogical content knowledge is widely distributed in science and mathematics teaching. This study aims to study how in-service science teachers react their role in the concept of Pedagogical Content Knowledge (PCK). Five in-service science teachers participated in this study through project leader teacher to change in science and mathematics instruction since 2010 which is supported by Institute of Teaching Promotion for Science and Technology (IPST). Interviewing, classroom observation, and informal small group discussion are employed. Data is analyzed and then presented by descriptive explanation in terms of knowledge base (Shulman, 1987). Findings revealed that in-service teachers can change their ideas how to react their role in PCK as well. They can employ instructional strategies and integrate content knowledge into classroom based on motivation in teacher profession. The findings will be discussed and developed instructional strategies in which relevant to philosophy and nature of science.

Key words: PCK; Pedagogical content knowledge; In-service teacher; Science teaching

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INTRODUCTION
The age of global change need more effective instruction, not only student make themselves to supported this age, but also teachers should be reacted their knowledge in the complexity. Key aspects of the complexity are widely used term *pedagogical content knowledge*, which incorporates the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners and presented for instruction (Shulman, 1987). Teacher should have declarative knowledge of the content and pedagogy for authority and supports the idea that teaching is a profession (Ball *et.al*., 2008, p. 404).

The key component of PCK, is the knowledge of students' understanding, conception, and misconception of lesson. PCK can help teachers to interpret and shape students' learning actions as well as to effective instruction (Magnusson *et.al*., 1998). Shulman (1986, p. 9) introduced PCK as a specific category of knowledge to the dimension of subject matter knowledge for teaching. Also, PCK is namely distributed, the knowledge base for teaching. Teacher knowledge was to be organized into printed formats. They should be included seven categories for effective science instruction (Shulman, 1987, p. 8).

• Content knowledge

• General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter

• Curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers

• Pedagogical content knowledge, that special amalgam

of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding

• Knowledge of learners and their characteristics

• Knowledge of educational contexts, ranging from the working of the group or classroom, the governance and financing of school districts, to the character of communities and cultures

• Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds

PCK can be implied as a transformation of subject matter knowledge that can be used effectively and flexibly in the communication process between teachers and students during classroom practices (van Driel *et.al*., 1998; Eilks and Markic, 2011; Halai and Khan, 2011). Teachers should know and how they should teach their students by focusing on subject matter, content, and incorporated pedagogy to achieve classroom. This conception can be described as a transformation of teacher knowledge from a variety of domains of knowledge, which includes subject matter knowledge, pedagogical knowledge, and knowledge about content (Botha and Reddy, 2011). PCK is argued to be a useful concept in the sense that it has opened up thinking about the distinctive forms of professional knowledge of teachers in different subjects (Abell, 2008; Bausmith and Barry, 2011) about the knowledge, teaching skills, and abilities of teachers.

The quality of teachers and the teacher education process has important consequences for improvement in science education. Shulman (1987) believed that professional development in teacher education should combine knowledge in content and pedagogy to more effectively prepare and develop science teachers (Kaltakci, 2011), also engage science teachers to understand about nature of science (Zeidler and Lederman, 1989; Abd-El-Khalick and Lederman, 2000a; Abd-El-Khalick and Lederman, 2000b; Abd-El-Khalick, 2005; Abd-El-Khalick and Akerson, 2004). PCK includes knowing which teaching approaches fit the content and how elements of the content can be arranged for an effective science teaching. The Institute of Teaching Promotion for Science and Technology (IPST) launched project leader teacher to change in science and mathematics instruction. The project aims to engage teachers to perform PCK into their classroom. Based on believes teachers' understanding and enactment of how to help a group of them understand specific subject matter using multiple instructional strategies, representations, and assessments while working within the contextual, cultural and social limitations in the classroom environment. (Park and Oliver, 2008)

This study tries to explore how in-service science teachers percieve their role in PCK concept. The data is collect through group interview, classroom observation, and informal small group discussion. Data is analyzed and interpreted by descriptive explanation. The finding can be discussed and presented to how in-service science teachers understand and employ PCK to their classroom as well as integration of content and pedagogy.

METHODOLOGY

Research Design

This study was designed as a qualitative case study in terms of five in-service teachers react their role in the concept of pedagogical content knowledge (PCK) Case study was generally focused on classroom phenomena which represent individual group. The phenomena were described by providing deep knowledge from various sources of data. Interviewing, empirical observation, and informal group discussion were employed.

Context

The study was conducted within a project whose supported by Institute of Teaching Promotion for Science and Technology (IPST), this project engaged in-service science teachers to understand and implement instructional strategies in relation to content. This case study was done in collaboration with five in-service teachers to establish their perspectives on the concept of PCK. The policy maker and also supporter requires teacher make a change in their instructional roles. A process of well known "professional development" was done by IPST and added mentoring process to all participated schoolers.

Participant

The Institute of Teaching Promotion for Science and Technology (IPST) designed participant in this project should be has mentor, mentees, and supervisor. This exploratory study described in terms of case study, five in-service teachers taught in Payakaphumwittayakarn school, Mahasarakham province were monitor. Most of participants were supported and subsidized by IPST, professional development was employed to them by up rising their instructional competency in science. Innovative lesson plan, instructional strategies, and change in their science teaching style were engaged.

In this project, development of teacher competency for changes in science and mathematics focuses on the way to develop school personnel which have responsibilities to support science and mathematics education at school level. School administrator, teachers, teacher mentor, and supervisor are concerned. Mentor has been cultivating in pedagogical content knowledge, teaching strategies, and reflective thinking techniques as well during this project. This case study selected a group of five (3 male and 2 female) in-service science teachers: 2 biology, 1 general science, 1 physics, and 1 chemistry participated. They have been trained innovative instruction especially science subject by IPST in collaboration with experts who have been working in science.

The progress of their role in PCK was monitored by a few times per semester. The participants took the school science experiences and then informal small group discussion was conducted. By this way they could share their opinions, observations, empirical experiences, and classroom evaluations that they already observed during the science lesson of their PCK were expressed and reported.

Data Analysis

The data provided as voice records from the interviews, descriptive written from observations, and phenomena exploratory description. Data will be analyzed through concept PCK in teachers' teaching knowledge base (Shulman, 1987).

FINDINGS

The four major sources for the teaching knowledge base: (1) scholarship in content disciplines, (2) the materials and settings of the institutionalized educational process, (3) research on schooling, social organizations, human learning, teaching and development, and the other social and cultural phenomena that effect what teachers can do, and (4) the wisdom of practice itself. The phenomena in case study can be elaborated.

Scholarship in Content Disciplines

Five in-service teachers in this study had a various general background. The leader teacher had teaching experiences in science especially secondary school level engage his profession. He was trained by IPST and learned by his best through classroom research. Others left consisted of 1 physics teacher, 2 biology teachers, 1 general science teacher, and 1 chemistry teacher learned how to seeking source of knowledge by knowledge transmission. They have a sharing experience hours in which how to communicate with their students by constructivist approach.

"We are very fortunately to promote our profession by school administrator and IPST and also school administrators engage us to learn how to teach science by our best...we learn too much in pedagogical knowledge in science…"

The content disciplines were formed by national science education curriculum in which established by Ministry of Education and IPST. Nature of science was defined and promoted in all content knowledge as well as teachers can do.

"… students should be learned how science works and process of science should be incorporated in science classroom …"

"… curriculum sometimes limit instructional framework, nature of science is not content … school need to put subject matter and content to students based on the academic reason and educational policy… "

Teachers aware not only content knowledge which school need to improve and push up ordinary national education test (O-NET), but also nature of science in the last strand of science subject should be integrated in classroom through various kind of instructional strategies. They expressed that content knowledge are insufficient because learning environment was forced by many factors e.g. online learning, cultural and societal changes, educational policy, and so on. In this phenomenon, teachers have to change their teaching behavior and the ways of transferring their knowledge to students.

Materials and Settings of the Institutionalized Educational Process

Most of in-service teachers have experienced in instructional design and development, especially electronics learning tools such as e-books, courseware, and computer assisted instruction. IPST engages them to learn more how to develop more effectively instructional tool by participating in teaching-learning media implication workshop program.

"… in this program was supported by IPST by allowing us to participate with others, presenter was invited and come from aboard … we learn much more how to develop instructional tools and medias in science teaching, it helps us to share ideas with others and change our mind in science teaching …"

Workshop can help teachers to get new ideas and learn to share instructional practices with others because some content is presently abstract; it needs to present content knowledge through media in appropriately.

"We learn to use educational game and media to invite our students in classroom as well … most of my students are very excited with educational technology more than teacher speak out"

"It is very surprisingly, we can engage our students by employing many instructional media and techniques such as exit ticket, gallery walk, dominoes...Yes !! we can do it"

While this program observed as sufficient findings in terms of their methods and strategies because of using instructional media in the course and instructional techniques. They have to spent more time to prepare media not only design and develop, but also content should be considered. Sometime they employ many strategies as much as they have learned that makes anxiety about content knowledge in which student should be known and learned.

"I change techniques of exit ticket from student write what they have learned into paper and sent it to me by assignment my student write what they have learned in to paper and hang it on the knowledge's tree"

The pedagogical knowledge is emerged during science classroom, teachers applied their ideas and techniques to incorporated in classroom because they believed that innovative lesson plan will bridge the gap between content and pedagogy not only teachers, but also students learn

more to adapt their learning behavior with new things.

Research in Which Effect what Teachers can do

The key successful factors to lead in-service teachers in this study, classroom research experiences are considered to describe in terms of changing process. Five in-service teachers share their ideas and take a cooperation to conduct a research at least a few project of study per academic year. Inquiry-based learning is employed to implement in science classroom, also educational media and innovative lesson plan is allowed as well as contemporary research.

"We are very happy to conduct an educational research because it is our responsibilities to answer how to be professionals, we are not only put some contents to science classroom, but also inquiry-based learning between teacher and students are significantly consideration"

Most of research was initiated by instructional activities in which engage their students to understand scientific concept determining in national science education curriculum. Instructional model and others educational innovation are introduced as well as nature of science should be incorporated through contemporary instruction such as backward design, inquiry-based learning, project-based learning, problem-based learning, KWL, cooperative learning, and media-based learning.

"Our students are very excited in science classroom when we use various kinds of instruction, they are concentrated with educational media and learning activities, we are thanks to IPST to support and change teaching style of us through PCK... we learn to develop students' achievement by conducting classroom action research and education research in which we can do…"

Classroom action research is suitable for in-service teachers to engage and concern students' achievement. They learn to introduce innovation to classroom, also they learn to open opportunity of learning self and group competency in science education.

Wisdom of practice itself

In sum, the scholarship in content disciplines, materials and settings of the institutionalized educational process, research on schooling, and the other social and cultural phenomena that effect what teachers can do that cultivate in-service teachers to construct wisdom of practice.

"… exit ticket is employed as much as I can, but some students habited and bored with this strategies, so I have opinion to use exit ticket in terms of tree of knowledge…"

"…PCK engage me to teach science by my best, content knowledge, classroom activities, teaching strategies, educational media-based teaching, and classroom research are importance for development of science education…"

The wisdom of in-service teachers in this study is not emerged by one, but cooperative learning and PCK-based model which IPST developed influences to science teachers and quality of education. There is no question about PCK in professional development, but we have to answer how to implement and engage PCK in school science and mathematics as wide as curriculum requires.

DISCUSSION

The study revealed that PCK can engage in-service teachers to achieve their students, and implement their innovative lesson plan as well. Teachers develop themselves into the driving forces and self-determined causers of a change in teaching practices. The necessary competencies for structuring knowledge about possible changes in the sense of PCK made themselves plainly visible in the above mentioned. Many of the education innovations cover various suggestions and requirements science education.

Attributes of in-service teachers based on PCK-based practices can help them to meet nature of science (Duschl, 1990; Lederman and Lederman, 2004; Hipkins *et.al*., 2005; Nuangchalerm, 2009). They have to understand that teaching and learning based on national science education and key performance index of science education need appropriately content and pedagogical knowledge such as questioning method, ICT-based classroom, innovative learning activities and so on. They learn step-to-step in develop learning activities and conduct classroom research, also learn to be a role model and teacher profession. Teacher should have declarative knowledge of the content and pedagogy for authority and supports (Ball *et.al*., 2008, p.404).

The four major sources for the teaching knowledge base that described by Shulman (1987) in terms of scholarship in content disciplines, materials and settings of the institutionalized educational process, research on schooling and development, and wisdom of practice itself. Five in-service teachers in this study had teaching experiences by their professional experiences.
They expressed that content knowledge are insufficient because learning environment was forced by many factors e.g. online learning, cultural and societal changes, educational policy, and so on (Matthews, 1994).

Most of in-service teachers have experienced in instructional design and development. This project, IPST engages them to learn more how to develop more effectively instructional tool by participating in teaching-learning media implication workshop program as much as they can participate. Also the strategic plan, innovative instruction in science classroom as workshop that promote teachers to get new ideas, but they expressed that need more time to prepare media to concentrate with instructional design and media creation.

However, instructional design and implication of instructional media can help them to conduct classroom

research. In-service teachers learn to share their ideas with others and take a role in participatory action research. They concerned nature of science, content, and pedagogy that classroom action research allows to meet national science curriculum requirements. It can further effects to stronger teacher professionalization. PCK can change their view and attitudes about teaching and learning based on development of best competencies in the structuring and critical examination of teaching practices (Eilks and Markic, 2011).

In sum, PCK help teachers to incorporate nature of science relevant to teaching-learning actions, teacher knowledge was implied by various kind of wisdom and practices in term of transformation of subject matter knowledge that can be used effectively (Shulman, 1987; Eilks and Markic, 2011). Teachers should know and how to teach their students by focusing on subject matter, content, and incorporated pedagogy to achieve classroom (Botha and Reddy, 2011). They combined knowledge in content and pedagogy to more effectively prepare and develop science teachers.

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REFERENCES

Abd-El-Khalick, F. (2005). Developing Deeper Understandings of Nature of Science: The Impact of a Philosophy of Science Course on Preservice Teachers Views and Instructional Planning. *International Journal of Science Education, 27*(1), 15–42.

Abd-El-Khalick, F. and Akerson, V. (2004). Learning as Conceptual Change: Factors Mediating the Development of Preservice Teachers Views of Nature of Science. *Science Education, 88*(5), 785–810.

Abd-El-Khalick, F. and Lederman, N. G. (2000a). Improving Science Teachers Conceptions of the Nature of Science: A Critical Review of the Literature. *International Journal of Science Education, 22*(7), 665–701.

Abd-El-Khalick, F. and Lederman, N. G. (2000b). The Influence of History of Science Courses on Students Views of Nature of Science. *Journal of Research in Science Teaching, 37*(10), 1057–1095.

Abell, S. K. (2008). Twenty Years Later: Does Pedagogical Content Knowledge Remain a Useful Idea? *International Journal of Science Education, 30*(10), 1405-1416.

Ball, D., Thames, M. and Phelps, G. (2008). Content Knowledge for Teaching: What Make it Special?. *Journal of Teacher Education, 59*(5), 389-407.

Bausmith, J. M. and Barry, C. (2011). Revisiting Professional Learning Communities to Increase College Readiness: The Importance of Pedagogical Content Knowledge. *Educational Researcher, 40*(4), 175-178.

Botha, M.L. and Reddy, C.P.S. (2011). In-service Teachers' Perspectives of Pre-Service Teachers' Knowledge Domains in Science. *South African Journal of Education, 31*, 257-274.

Duschl, R. A. (1990). *Restructuring Science Education: The Importance of Theories and Their Development.* New York: Teachers College Press.

Eilks, I. and Markic, S. (2011). Effects of a Long-Term Participatory Action Research Project on Science Teachers' Professional Development. *Eurasia Journal of Mathematics, Science and Technology Education, 7*(3), 149-160.

Halai, N. and Khan, M. A. (2011). Developing Pedagogical Content Knowledge of Science Teachers Through Action Research: A Case Study from Pakistan. *Asia-Pacific Forum on Science Learning and Teaching, 12*(1), 1-23.

Hipkins, R., Barker, M., and Bolstad, R. (2005). Teaching the "Nature of Science": Modest Adaptations or Radical Reconceptions? *International Journal of Science Education, 27*(2), 243–254.

Kaltakci, D. (2011). Integrating Teaching and Learning in Pre-Service Physics Teacher Education. *Balkan Physics Letters,* 95-98.

Lederman, N. G. and Lederman, J. S. (2004). Revising Instruction to Teach Nature of Science. *The Science Teacher, 71*(9), 36-39.

Magnusson, S., Borko, H. and Krajcik, J. (1998). Nature, Sources, and Development of Pedagogical Content Knowledge for Science Teaching. In Gess-Newsom, J. and Lederman, N. (eds). *Knowledge for Science Teaching*. Kluwer: USA.

Matthews, M. R. (1994). *Science Teaching: The Role of History and Philosophy of Science*. New York : Routledge.

Nuangchalerm, P. (2009). Preservice Teachers Perception about Nature of Science. *The Social Sciences, 4*(5), 463-467.

Park, S. and Oliver, J.S. (2008). Revisiting the Conceptualisation of Pedagogical Content Knowledge (PCK): PCK as a Conceptual Tool to Understand Teachers as Professionals. *Research in Science Education, 38,* 261-284.

Shulman, L.S. (1987). Knowledge-base and Teaching: Foundations of the New Reform. *Harvard Educational Review, 57*(1), 1-22.

Van Driel, J.H., Verloop, N. and de Vos, W. (1998). Developing Science Teachers' Pedagogical Content Knowledge. *Journal of Research in Science Teaching, 35*(6), 673-695.

Zeidler, D. L., and Lederman, N. G. (1989). The Effects of Teachers Language on Students Conceptions of the Nature of Science. *Journal of Research in Science Teaching, 26*(9), 771–783.

