Korean Science Teachers' Pedagogical Content Knowledge (PCK) Represented in Teaching Practice at Middle School Classroom

The purpose of this study was to investigate middle school science teachers' Pedagogical Content Knowledge (PCK) represented in instruction and by other influential factors. For this study, 3 teachers were chosen as subjects. The data of this study were collected through qualitative research methods, such as semi-structured interviews, classroom observations and CoRe questionnaires. Data were analyzed by using a constant comparative method after transcription. In this study, one of the participant's (Kim) PCK was characterized as being inquiry-driven teaching. Another participant's (Ryu) PCK, was characterized as having an orientation towards activity-driven teaching Another teacher's (Park) PCK was characterized as having a didactic orientation for transmitting the facts of science. The three teachers' PCK that were represented in science classes were affected by the teachers' own practical experiences, textbooks, and learning materials. But their PCK was not affected by their university studies and their teacher training program. From these results, it was concluded that understanding learners was a very important component in developing teachers' PCK. The teaching experiences were main factors in understanding their learners. Therefore, it is suggested that teacher education programs for pre-service and in-service teachers need to design programs that develop teachers' PCK.

Introduction

In recent studies, Shulman (1986) conceptualized PCK as the core of teacher expertise. The concept of PCK was referred to as the teacher's interpretation and transformation of subject-matter knowledge in the context of facilitating student learning (Van Driel, *et al*., 1998). Also, in the specific situation of the classroom, PCK was developed through teaching practice, which was the knowledge that grew from working in the external physical environment around teachers, as well as the kind of knowledge that came from different ways of thinking and beliefs, and the intellectual environment (Van Driel, et al., 2001). However, not all teachers received professional feedback and were isolated in their classrooms. In addition, in the situation of Korea, the definition of PCK was

confusing for members of the science education community. This is because there were diverse definitions of PCK, and there were few studies that concretely applied PCK to current practices in the science classroom (Loughran *et al*., 2004). , Actual research for in-service teachers' PCK had not been thoroughly studied in science education classrooms in different middle schools. Therefore, this study investigated middle school science teachers' PCK that was represented in instruction, as well as the factors that influenced the teachers' PCK.

Magnusson, Krajcik and Borko (1999) suggested components of PCK for science education. They defined PCK as a result of *transforming* the knowledge from the other domain, which includes subject matter knowledge and beliefs, pedagogical knowledge and beliefs, knowledge and beliefs about context. The authors also conceptualized PCK for science teaching as consisting of five components: an orientation towards teaching science, knowledge and beliefs about the science curriculum, knowledge and beliefs about students' understanding of specific science topics, knowledge and beliefs about assessment in science, and knowledge and beliefs about instructional strategies for teaching science (see Figure 1).

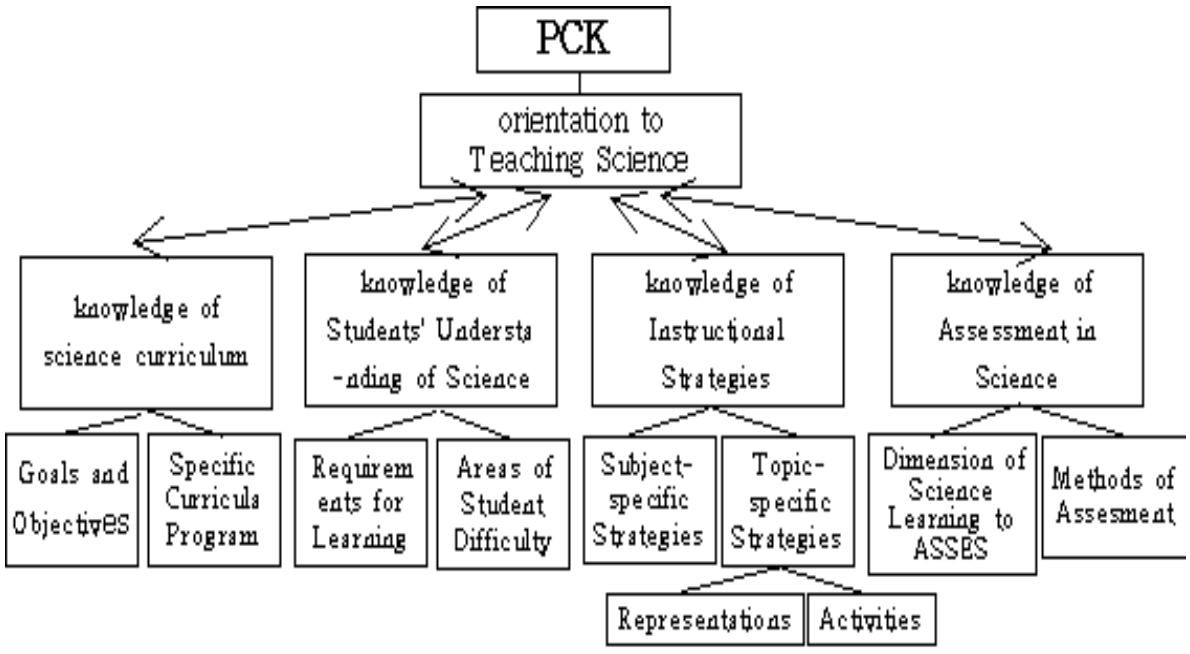

Figure 1. Five components of PCK for teaching science(Magnusson, Krajcik and Borko, 1999).

Method

Participants

The participants were 3 in-service teachers and they were all women, working at the same middle school in an urban area. Their academic background was also in Earth Science. Kim, one of the participants, was in her early 40's, and had 11 years of teaching experience in middle school, as well as a master's degree. Ruy, one of the other participants, was in her mid-30's, and had four years of teaching experience in high school and six years in middle school. Finally, Park was in her late 20's and had 2 years teaching experience in middle school.

Data Collection

Data were collected for 7 months from multiple sources, including classroom observations, semi-structured interviews, and CoRe questionnaires. The participant observation method was used throughout the study with a fellow researcher. The topic of the lessons we observed was related to 'property of matter'. Interviews were conducted several times: before and after classroom observation, after analyzing the transcripts of classes, and after viewing a video of their own class. The CoRe, which was developed by Loughrane et al. (2004), was also used as a tool to have the teachers express their knowledge of the subject. The CoRe consisted of 8 questions. The researcher explained the response method of CoRe to the three teachers. They prepared CoRe related lessons of melting point and density for their classes.

Data Analysis

The data that were collected from multiple resources were transcribed and analyzed with one science education specialist and two fellow researchers by using a constant comparative method(Merriam, 1998). Without using a pre-established system of categories, categories were developed from an interactive process based on the data that were obtained and constantly read and compared(Chams, 2000; Glaser & Strauss, 1967). Any disagreements were discussed until a consensus was reached. This entire process took 7-8 months. In order to investigate the PCK of in-service teachers, there were some modifications made to the components that Magnusson, Krajcik, and Borko (1994) had suggested. These were the

following components that were used to find out the teachers' PCK: orientation towards teaching science, knowledge and beliefs about science curriculum, knowledge and beliefs about students' understanding, and knowledge and beliefs about instructional strategies. These components were also divided into two aspects of teaching strategies and management strategies. However, the component of assessment knowledge was excluded because it became difficult to analyze since the data were not insufficient. The factors that affected the teachers' PCK were classified into two categories: 1) external factors, such as the type of university education, teacher training, peer interaction (based on classroom observations and learning materials), textbooks, school environment, business processes, and 2) internal factors such as teaching experiences, learning experiences, curiosity, reflective thinking, efforts, and understanding about the nature of science.

Findings and Discussion

The teachers' PCK

Kim: Kim's PCK was characterized by inquiry-driven teaching. She had the belief that science is the answer to the question 'why'. She also formed knowledge of the process that links science education and knowledge of the curriculum very well. Also, she thought that it was important to learn about the process of inquiry by using strategies of cognitive conflict. Also, Kim assumed her students as active learners who thought and learned the same as Kim herself. She also used classroom management strategies, such as the three-minute waiting-time, individual episodes, and current science issues to promote students' intrinsic motivation.

Ryu: Her PCK was characterized by an orientation of activity-driven teaching and had the belief that students learned science by doing hands on activities. She also assumed students as passive learners who need to be guided in learning science. So, she tried to create interest. Her assumption about students had been influenced by her teaching experience and her interpretation of the curriculum. Ryu made a great effort to transmit knowledge to students. She was professional to her students and used teaching strategies to stimulate extrinsic motivation.

Park: Park' PCK was characterized by a didactic-orientation to transmitting scientific facts. Because she believed that it was important for students to gain good grades on the exam, so she made students solve test problems repeatedly. But, inconsistently, she had beliefs that teachers must know their students' pre-conceptions and should become assistants to help students participate actively in class.

Factors that influenced the teachers' PCK

As shown in Table 1 below, there were various factors that influenced the teachers' PCK (see Table 1).

Table 1. Externall and Internal factors that influenced the PCK of Teachers

	Factor	Kim	Ryu	Park
External factors	College education	X	X	X
	Teacher training	X	X	X
	Textbooks	O	O	O
	Interaction with peer group	O	O	O
Internal factors	Experience of thinking about teaching t (understanding)	O	O	O
	Experiences as learners	O	O	O
	Beliefs about learning	O	O	•
	Teaching experience	O	O	O
	Curiosity	O	X	X
	Knowledge about science	O	X	X

(O: helpful, X: not helpful, • : not commented explicitly)

There were internal factors that commonly influenced the three teachers' PCK, such as teaching experiences, experience as learners, and beliefs about learning. There were also common external factors that influenced the teachers' PCK, such as textbooks and the

interactions with the peer group. College education and traditional teacher training courses did not influence the formation of the teachers' PCK meaningfully.

In particular, one of the subjects of the study, Kim, was more aware of understanding the nature of science and she had a lot of intellectual curiosity about 'Why' than the other two teachers. These factors developed Kim's inquiry-driven PCK compared to the other teachers.

Concluding Remarks

Through this research, it was found that understanding the learners was an important component for developing the PCK. Teachers' PCK varied in their assumptions on whether students were active learners in class or not. From the moment that the teacher assumed the students to be passive learners, it was difficult to develop the teachers' PCK as being inquiry-driven. So it was ultimately important to understanding both the learners and teachers' experiences. Also, reflective thinking of subject-content based on the nature of science was important in the formation of the teachers' PCK. Ultimately, internal factors affected the teachers' PCK more than the external factors.

As a result, we suggest that further research on the following topics: first, the teacher training program should include reflective thinking of subject-content through teachers' own practical experience. Second, the teachers suffered difficulties from developing their own PCK individually. Therefore, we suggest that a supporting system should be in place for the teachers to share knowledge with peer groups and educational specialists. Third, PCK was the knowledge that was obtained through teaching practice linked with teacher's beliefs. Also, beliefs didn't change quickly. Therefore, it is necessary for programs to be in place to support and help in developing teachers' PCK continuously.

In addition, the teachers in this study wanted to know more insights of teaching methods related to teaching subject-content. Therefore, practical strategies related to specific topics are needed to develop advanced teachers' PCK.