교육학석사 학위논문

Action Research Using Cogenerative Dialogue to Improve PCK in a Beginning Teacher's Elementary Science Classroom

초등과학수업에서 초임교사의 **PCK**향상을 위한

Cogenerative Dialogue 활용 현장연구

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이 논문을 교육학석사 학위논문으로 제출함

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ABSTRACT

Currently, there is limited research about beginning elementary science teachers in Korea and the methods they can use to develop their Pedagogical Content Knowledge (PCK) to improve their science teaching. In this thesis, I use PCK as a theoretical framework for analyzing my teaching practices as a beginning teacher to make clear the need beginning teachers have for continuing their professional development once they are in the classroom. I examine how my initial PCK shaped my ability to be effective as a beginning science teacher in a Korean elementary classroom and I trace how my engagement in an action research project with my students expanded my PCK, which also helped to improve my science teaching practices. Thus, the focus of this research is on examining how new teachers can transform their teaching by expanding their PCK through teacher-directed classroom research.

Conducted within the methodological framework of action research, this study examines the ways in which beginning teachers can engage students in collaborative research efforts with their students to overcome the isolation beginning teachers experience and to work individually and collectively to resolve problems in classroom teaching and learning. Specifically, this study introduces a qualitative research method called cogenerative dialogue (coupling video analysis and structured discourse between teachers and students) to develop targeted domains of teacher PCK, including knowledge of students as learners, knowledge of how to manage the classroom (especially during inquiry science activities), and how to effectively implement inquiry instructional strategies in the elementary classroom.

Using Guba and Lincoln's (1989) authenticity criteria as a framework, I trace my changing PCK through four stages of the cogenerative dialogue process. During cogenerative dialogues, teachers and students engage in conversations in order to critically examine and reflect on shared events and activities (Tobin & Roth, 2006) from the classroom. Participants included all 25 students in an elementary classroom, a university researcher (Dr. Martin and Ms. Park) and me as a teacher-researcher. The research was conducted during a four-month period and data was collected in both the classroom and the laboratory during second semester in 2012. Student research notebooks, teacher field notes, video captured from science lessons and cogenerative dialogues, and interviews with students were collected as data.

Findings from this research suggest that by involving students in cogenerative dialogues, beginning teachers are provided with valuable insights into how elementary students think about school, science, and teaching and learning – which can help expand a beginning teacher's PCK. In addition, when students are given chances to contribute to the improvement in their own classroom, they can do so by engaging in problem solving activities and by cogenerating suggestions for improving teacher instructional strategies and patterns of student engagement. These findings suggest that teacher education programs could better support beginning teachers by placing greater emphasis on how to conduct action research, including how to implement cogenerative dialogues, in an effort to support beginning teachers to be successful in the classroom.

Keywords: Beginning teacher, Pedagogical Content Knowledge, Cogenerative dialogue, Action research, Authenticity criteria, Science teacher education
Student Number: 2011-23654

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CHAPTER 1

THE PROBLEM

"O Lord, thank you for making me choose to devote my life to being a teacher."

(Oh, The Prayer of a teacher from "*Teacher*", 1997)

During my[1] first year as an undergraduate student in the elementary education department at my university, I was assigned to read the book *Teacher* (Oh, 1997). A professor had assigned this book for homework, asking all students to read the book and write a reflection. The book was published in the 1990s, and it appeared to be a collection of common-sense stories about teaching, but did not provide many impressions or information about actually working as a teacher. As a freshman I was not ready to accept these feelings about teaching and being in school with young students, but there was no choice, so finally I opened the book and started to read. As I kept reading the book, however, I realized how important it is to be a teacher and to be standing in front of the children who will lead the future. Oh says that teaching is not just a job, it is a vocation, so teachers should have many virtues, such as sacrifice, meditation, love, spirit of research, and vision. I had never thought that being a good teacher requires so many things other than just content knowledge. It made me feel the pressure of responsibility. I still sometimes recall that feeling when I am in the classroom with my students.

Since I kept these feelings in my mind and tried not to forget them in my life as an elementary teacher, I cried in the empty classroom on the first day I started my career as an elementary school teacher. My first day of teaching came

[1] In this thesis, I'm going to examine some of the issues from a first-person perspective, employing action research in the classroom and telling the story from my perspective.

suddenly and I found that even though I had spent a lot of time preparing in my teacher education program, I had not yet really formed a strong educational point of view. I thought I was well prepared when I graduated the university with top honors, got the license to be an elementary teacher, passed the teacher certificate examination, and finally became a public elementary teacher. But it was totally different from what I expected. The only thing that I did on the first day was introducing myself to my students and other teachers. I still cannot forget the scene of the students staring at me in silence, waiting for my instruction. I was almost afraid of them as I looked out at the students. I really wanted to run away as I felt I did not know what to do. When I asked other teachers, they encouraged me and said I would figure out what to do as I spent more time with my students. They were pleased to help me, but I did not even know what to ask them about teaching or the students.

In addition to not feeling competent about what to do each day, much of the time that I needed to spend preparing for each lesson was constantly being interrupted by pop-up computer messages from my principal or the administrative office ordering that I complete administrative tasks unrelated to my teaching. These tasks required an inordinate amount of my time and attention. But these were not the only problems as my students constantly caused big and small problems and parents were constantly requesting counseling for their children. These pressures weighed heavily on me both in the classroom and outside of it. I also found that the only way I could manage the classroom was by yelling loudly at the students to make them sit down in their chairs. Each day, these same problems presented themselves over and over, but I never had time to find solutions and being "a beginning teacher" could not be an excuse forever, so I knew I had to do something to improve my situation.

1.1 INTRODUCTION

These experiences that I describe as a beginning teacher are not unique. A great deal of research has been done on beginning[2] teachers which demonstrates teachers' lack of content knowledge, inability to effectively manage classroom behaviors, inability to effectively handle administration work, etc. Unfortunately, teacher education programs cannot perfectly prepare beginning teachers to meet these challenges. However, much research suggests (e.g., Barnett & Hodson, 2001; Ball, Thames, & Phelps, 2008) that when teacher education programs support pre-service teachers to build their pedagogical content knowledge (PCK), beginning teachers are better prepared to meet the challenges previously described. PCK refers to teachers' specialized knowledge necessary for teaching specific subject matter, including knowledge of learners, instructional representations, and assessment (Grossman, 1990; Magnusson, Krajcik, & Borko, 1999).

In this thesis, I use PCK as a theoretical framework for analyzing my teaching practices as a beginning teacher to make clear the need beginning teachers have for continuing their professional development once they are in the classroom. I examine how my initial PCK shaped my ability to be effective as a beginning science teacher in a Korean elementary classroom and I trace how my engagement in an action research project with my students expanded my PCK, which also helped to improve my science teaching practices. Thus, the focus of this research is on examining how beginning teachers can transform their teaching by expanding

[2] In this study I refer to beginning teachers as teachers who have been teaching for less than 3 years.

their PCK through teacher-directed classroom research.

In the sections that follow, I clearly articulate what I mean by PCK by describing the literature about PCK and showing how this research has been used to make sense of the challenges that beginning teachers have in elementary science classrooms. To provide context for this discussion, I will first introduce how the current teacher education system in Korea educates news teachers. By providing some examples from my own experience, I illustrate how deficiencies in teacher PCK can limit beginning teachers' abilities to effectively teach school science and I assert that beginning teachers need tools to help them continue to develop their PCK after graduating from their initial teacher education programs. Thus, the focus of this research is on examining how a beginning teacher can utilize action research in a classroom to build their PCK.

In chapters that follow, I clearly delineate how I conducted this research utilizing an action research methodology incorporating a method called cogenerative dialogue. I share findings from a semester-long teacher-directed action research project in which I engaged students from my 5th grade science class as co-participants to help me to expand my PCK and to transform my science teaching practices. I conclude the thesis by suggesting ways that teacher education programs could support beginning teachers to expand their PCK once they are in the classroom by preparing them to use tools, such as action research and cogenerative dialogue, to continue to develop professionally and improve their teaching practice.

1.2 THEORETICAL BACKGROUND

In this section, I introduce the concept of PCK and I describe how I used it as a theoretical lens for examining my needs as a developing elementary science teacher. I use this introduction to highlight challenges beginning teachers face in general and in the context of science teaching and I make clear the connection between teacher challenges and deficiencies in PCK**.** Specifically, I highlight aspects of PCK that served as the main focus of my analysis for this study.

1.2.1 Origins of Research on Pedagogical Content Knowledge

In the early 1980s, dissatisfaction was growing with the state of American educational research and there were widespread calls researchers to more critically examine the profession of teaching and to promote school reform (Carlsen, 2002). Numerous scholars in different disciplines set about to describe the nature and characteristics of teachers' knowledge, specifically researchers were interested in understanding what makes a "good teacher". Earlier researchers had described teacher knowledge in practical terms as the "wisdom of practice" that developed over time (Schwab, 1971). Throughout the 1970s and 1980s, there was a growing debate about whether "good teachers" could be trained in schools of education or whether "good teachers" simply possessed or if some kind of "practical knowledge" about teaching and learning developed over time, which was distinct from that which was learned in teacher education programs. Underlying this debate were questions about whether teaching was a "real profession" that required complex knowledge and understanding about subject matter and learners, or if teaching was simply a set of pre-defined skills that could be taught to any person.

In the mid-1980s, Lee Shulman (1986, 1987) and colleagues (Shulman, Sykes, & Phillips, 1983; Shulman & Sykes, 1986) published a series of articles promoting a paradigm shift in educational research that re-positioned teaching as a profession, rather than set of skills and strategies to be learned. Shulman and his colleagues proposed a special domain of teacher knowledge that they termed *pedagogical content knowledge* (PCK). PCK referred to not only what teachers needed to know and understand about subject matter content, but also how to teach that specific content effectively, including, knowing what is likely to be easy or difficult for their students to learn, and how to organize, sequence, and present the content to suit to the diverse interests and abilities of the students. Thus, Shulman identified PCK as a unique form of knowledge necessary for teaching. Shulman (1990) contended that what skillful teachers do is transform their knowledge of scientific concepts into forms that are more accessible to their students by integrating their knowledge of their learners, representations of concepts, instructional strategies, assessments, and curricular resources to create meaningful learning opportunities for their students. Barnett and Hodson (2001) assert that effectively teaching science requires more than pedagogy, but is also impacted by the nature of the subject matter and teacher's understandings about their learners.

Shulman's view of subject matter knowledge was derived from the work of Schwab (1964), who defined two types of subject matter knowledge: substantive and syntactic. The substantive structure of a discipline is an organization of concepts, facts, principles, and theories, whereas syntactic structures are the rules of evidence and proof used to generate and justify knowledge claims in the discipline. Shulman (1987) reasoned that pedagogical knowledge included the general, not subject-specific, aspects of teacher knowledge about teaching such as learning theory, instructional principles, and classroom discipline as well as specific subject matter knowledge.

Grossman (1990) expanded upon Shulman's work, emphasizing three domains of teacher knowledge, including subject matter knowledge, knowledge of context, and general pedagogical knowledge – which each influenced a teacher's pedagogical content knowledge (PCK). Also applying the concept of PCK to science teaching, Magnusson, Krajcik, and Borko (1999) built upon Grossman's work to re-conceptualize PCK for Science Teaching as more than subject matter knowledge, knowledge of school context and general knowledge about teaching - but also included the a) teacher's orientation toward teaching science, b) knowledge and beliefs about science curriculum, c) knowledge and beliefs about students' understanding of science topics, d) knowledge and beliefs about assessment in science, and e) knowledge and beliefs about instructional strategies for teaching science (p. 96-97). More recently, Abell (2007) combined Grossman (1990) and Magnusson, et al., (1999) to more clearly depict PCK (see Figure 1.1) as consisting of the five components listed above and as being influenced and shaped by three knowledge domains (subject matter knowledge, pedagogical knowledge, and knowledge of context) (p. 1107).

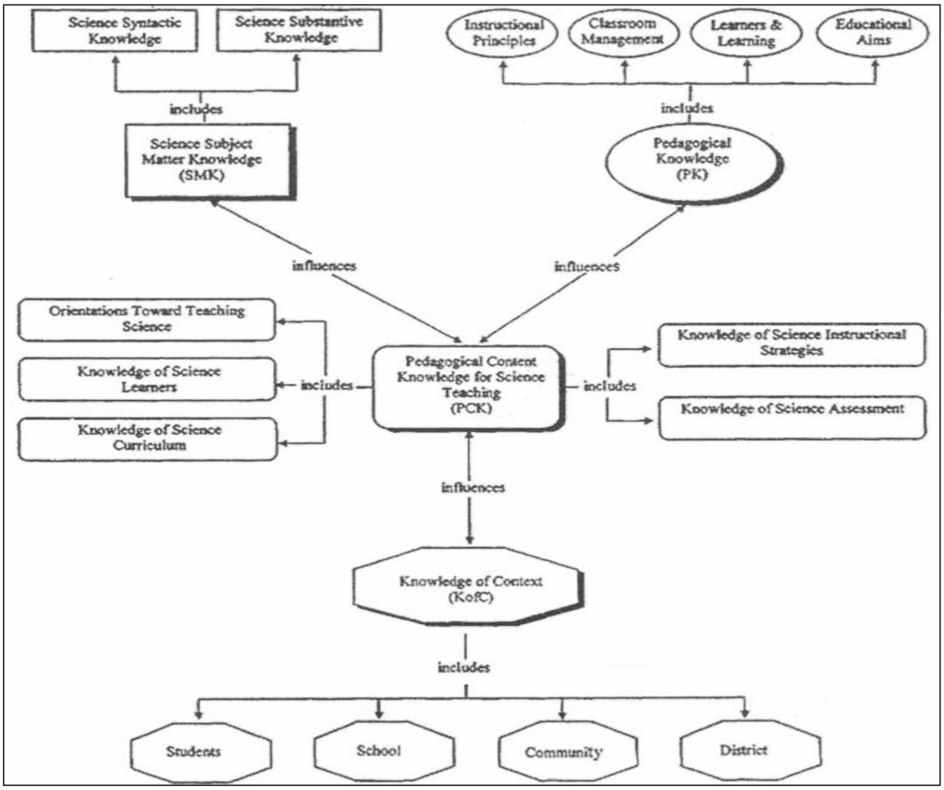

Figure 1.1 A model of science teacher knowledge (modified from Grossman, 1990, and Magnusson, Krajcik, & Borko, 1999)[3].

Abell's model (2007) highlights not only the need for teachers to possess different forms of knowledge, but she also emphasizes that teacher PCK is highly dependent upon the quality of teacher knowledge, teaching experience, and the ways in which teachers are able to integrate each component of PCK so they can design and facilitate effective science learning experiences. For example, not only must teachers draw on pedagogical knowledge, but they must also adapt it to the specific subject matter context. This requires that teachers have not only specialized knowledge for teaching specific subject matter, but they must also have other forms of PCK, including knowledge of learners, appropriate instructional representations,

[3] From Abell, S. (2007). Research on science teacher knowledge. In S. K. Abell and N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 1105-1149). Mahwah, NJ: Lawrence Erlbaum Associates.

and an understanding of how to develop and utilize assessments to measure student knowledge (Grossman, 1990; Magnusson, Krajcik, & Borko, 1999) and they must integrate all of these forms of knowledge while making decisions and enacting teaching practices in the classroom.

In my research, I argue that in order for teachers to effectively draw from individual components of their PCK, they must have opportunities to integrate these different forms of knowledge and to draw on them simultaneously while in "action" as a teacher. For beginning teachers, this is a considerable challenge. But for beginning teachers who are trained in teacher education programs that do not sufficiently provide opportunities for teachers to see connections between forms of knowledge and to practice integrating their knowledge through extended teaching practicums – it is even more a challenge.

To provide an example of what it means to need to integrate these different domains of knowledge while teaching a science lesson to my students, I would need to be able to access specific knowledge about science content (e.g., phases of the moon), pedagogical knowledge about how to manage classroom behaviors (e.g., strategies for keeping students in their seats and attentively listening to my lesson), knowledge of instructional strategies specific to the content and concept I am teaching (e.g., demonstrating phase changes using a lit bulb and two globes to cast a "shadow" on the moon), and a well-developed understanding of my students as science learners (e.g., anticipating common misconceptions 10- and 11-year old students have about lunar phases).

To contextualize the challenge a beginning teacher may face when attempting to draw on all of these different domains and then integrate them in the moment of teaching, I will briefly focus on knowledge of students as science learners (see Figure 1.1). To effectively teach a lesson on lunar phase changes, I would need to understand what fifth-grade learners are like, how fifth-grade students process information, how they learn from peer interactions, and how they make meaning from science activities and lectures. Even assuming there is no variation among learners in my classroom, this example demonstrates the complexity of "good science teaching". While my teacher education courses had covered topics related to adolescent learners, theories about learning, and topics such as misconceptions in science – as a beginning teacher who had very limited practical classroom teaching experience, my PCK about my students as science learners posed considerable challenges for me.

In the following section, I unpack this issue and how it limited my ability to effectively teach elementary science by describing the challenges that beginning elementary teachers face via a brief review of the literature. I expand on the literature by providing some examples of the challenges I had as a beginning teacher in an effort to contextualize the problems this thesis seeks to address in relation to the need for tools that can enhance PCK for beginning teachers – leading to improved science learning for students. Because PCK is not only related to knowledge gained from traditional coursework, but also from teaching experience and the ability to integrate different forms of knowledge while actually "in the moment" (Abell, 2007), it is important for me to reflect on my teacher preparation experiences. Thus, in the sections that follow, I contextualize the development of my PCK by examining my preparation as a teacher in Korea. In this description, I highlight several aspects of PCK, which I identified as particularly problematic for me as a beginning teacher and which became the focus for my research.

1.3 LITERATURE REVIEW

1.3.1 High Regard for the Teaching Profession in Korea

The teaching profession has long been highly appreciated in Korea (Sorensen, 1994). Being an elementary teacher especially is one of the most popular professions in Korea. Much research and many surveys show that a large number of students want to become elementary teachers, and their parents would like them to become elementary teachers as well. The Korea Research Institute for Vocational Education and Training surveyed 6,291 secondary school students and found that becoming an elementary teacher ranked first out of all possible professions because respondents believed becoming a public school teacher was a secure career (Ministry of Education and Science Technology [MEST], 2012). There are 5,895 elementary schools in Korea, 98.7% of which are public or national schools (Korean Educational Development Institute [KEDI], 2012). Therefore, most of the elementary school teachers in Korea work as government officials in these schools.

Traditionally, the teaching profession in Korea has been regarded as an honorable job, a view that is rooted in Confucianism, which is one of the fundamental bases of Korean cultural values (Sorensen, 1994). The Confucian saying, “King, teacher, and parents are equal,” means that kings, teachers, and parents should be respected equally for their noble jobs. Confucian respect for teachers is epitomized in an old Korean admonition: “Don’t even step on the shadow of a teacher.” Although Korean culture has changed radically through modernization, traditional respect for teachers is still evident in the high standards set for entry into the profession, showing the prestigious role of teachers in society (Sorensen, 1994).

Traditional Confucian teaching focused on memorization of the classics, history, philosophy and poetry and fostered a contempt for practical learning, which greatly influenced the sociocultural status of the teaching profession as being scholarly and above common vocations (Sorensen, 1994). In industrialized Korea, the differential treatment of academic and practical learning has been translated into a preference for occupations that require higher education, which brings greater social recognition and monetary rewards. Teaching is oriented to academic learning and requires higher education. Thus, in combination with the cultural respect that it receives, the teaching profession in Korean society is socially recognized and preferred over other occupations. The value of respect and social recognition outweighs that of monetary compensation for many Koreans and hence attracts highly qualified people to the teaching profession, even though the salary is not as high as some other careers (Korea Research Institute for Vocational Education and Training, 2007; OECD, 2005). Because being a teacher in Korea is seen as a high-status position, becoming a teacher is a very competitive and laborious process.

1.3.2 Being a Public Elementary School Teacher in Korea

Korean teacher preparation programs are relatively uniform compared to teacher education programs in other countries because the country has a centralized system of teacher education and certification. In most cases, those who want to acquire an elementary teacher certificate in Korea first need to gain admission to a university with a teacher education program and then they must compete to be granted admission to these programs. Only 10 of the 189 universities in Korea specialize in elementary education (KEDI, 2012), so there are limited possibilities for gaining admittance. Each year in Korea, about 650,000 students take the national academic aptitude test as part of the university selection process. Of these students, only about 7,000 students manage to gain admission to one of these 10 universities. Unlike in other countries, there are no alternative routes to gain admission, so it is very competitive to even become a student in a teacher education program in Korea. However, simply becoming a student in one of these programs does not ensure the student will be able to become a public school teacher.

The teacher preparation system for pre-service elementary school teachers in Korea requires high achievement in many different content areas. After entering an education university, pre-service teachers take a variety of content courses during a four-year period, including courses in philosophy and educational theory and courses that cover content area for all elementary school subjects. Korean elementary school teachers need to teach every subject in the primary grades, so undergraduate courses include ethics, Korean, social studies, mathematics, science, home economics, music, arts, P.E, and English. Pre-service teachers learn basic content knowledge for each of these subject areas. Additional requirements that pre-service teachers must fulfill are courses related to teaching methods for every subject that they are going to teach in school. These courses add up to a total of 124-136 credits, with most of the courses being 2 credits. Thus, elementary school programs are designed to develop teachers' content knowledge in a broad array of content areas.

In addition, every pre-service teacher is expected to specialize in a content area in which to take additional courses as a selected concentration. For example, pre-service teachers choosing to specialize in science need to take 21 credits of additional science courses, such as phytology or zoology. This is in addition to the general science and science methods courses already required of all teacher candidates. For example, I specialized in science and need to take courses in physics, biology, chemistry, earth science, elementary biology education, elementary physical education, elementary earth science education, elementary chemistry education, and two laboratory practicum courses.

Finally, in addition to content courses, all teacher candidates are required to complete a certain amount of time gaining practical teaching experience in a real classroom setting. In my own experience as a pre-service teacher at Daegu National University of Education (DNUE), as a freshmen I was required to complete a one-week field observation, followed by a two-week field observation in the second year. During these two observation periods, teacher candidates were expected to attend elementary school classrooms every day, observe real classrooms, and experience the daily routine of a school. They also received instruction from certified, in-service school teachers. During the third year, teacher candidates participate in a one-week practice course in a rural area school. Finally, seniors complete six-weeks of observation and teaching practicum experience.

Once pre-service teachers have successfully completed all these requirements in a national teacher preparation program, they are eligible to receive a nationally recognized teaching certificate. With this certification, the teacher can apply for employment in the private school sector or as a substitute or supplementary teacher in public schools. However, this certification does not make a teacher eligible for employment as a full-time teacher in a public school. To meet this standard for employment, there are several more hurdles to cross—which many pre-service teachers fail to do. Among 181,435 total elementary teachers, currently only about 7,917 work as “supplementary” teachers (KEDI, 2012). A supplementary teacher is a teacher who works in school as a substitute when the permanent teacher temporarily leaves the school for a reason such as maternity or parental leave (KEDI, 2012). These teachers are allowed to teach in public schools, but they do not enjoy the benefits of associated with being a civil servant employee.

To become a public elementary school teacher, candidates must first pass a multi-tiered qualification process. Specifically, the candidates must pass the National Teacher Employment exam, which is administered annually by a government-funded educational research institution, the Korea Institute for Curriculum and Evaluation (KICE) (Kang & Hong, 2008). Upon passing this test, teachers gain tenure to teach in public schools. This test is very competitive (Kwon, 2004).

The National Teacher Employment exam consists of three steps[4] in a multi-tiered process. Each year, only half of those who enter the first step of this three-tiered process will pass to the next level. The first step requires that the teacher pass an exam that focuses on general teaching knowledge, including educational philosophy, educational psychology, and educational administration, etc. In addition, the exam also includes content-specific questions related to the curriculum of the 14 subjects which all teachers are responsible for teaching in the primary grades (Seoul Metropolitan Office of Education [SMOE], 2010). For this reason, teacher preparation programs are expected to provide prospective teachers with various opportunities to acquire teaching knowledge through their curricula and teaching practicums (Kennedy et al., 2008; Tatto et al., 2008).

As mentioned previously, only the top 50% of the people who are initially

[4] The process varies somewhat in different areas, but the date of the examination is same. Every student has only one chance to apply the examination in one year. The policy of the examination changed somewhat in 2012.

allowed to take the exam qualify to continue to the second phase of the exam process. In the second phase, examinees must compete in an intensive curriculum exam and an essay. The essay asks candidates to contemplate certain educational situations or problems and then suggest appropriate solutions based on pedagogical background knowledge. The intensive curriculum portion of the exam asks questions about content, as well as knowledge about different instructional models, evaluation and assessment strategies, and philosophical questions about the purpose and the characteristics of each subject area. Again, only the top 50% of the people in stage two are allowed to move on to the final stage of the exam.

The final phase of the examination process includes an interview, development and assessment of a lesson plan, and an evaluation of teaching using a micro-teaching model. For the English lesson, both the interview and the micro-teaching are conducted in English rather than Korean. Only 1 of approximately 4.64 teachers who take the exam in Seoul passes the final phase (SMOE, 2010b). Thus, in Seoul, only 21.6% of the original candidates who qualified to enter the examination process actually succeed in becoming fully certified and employed teachers in public schools (SMOE, 2010a).

The process for becoming a public school teacher in Korea focuses heavily on assessing a candidate's subject matter knowledge and pedagogical knowledge. As a result, these teachers are highly qualified with regards to content knowledge. Nevertheless, even those students who graduate with a great deal of professional knowledge and have proved their ability by passing a very competitive exam still have difficulties working in schools where they are confronted with situations for which their teacher education programs could not prepare them. The limited opportunities to engage in an extended teaching practicum greatly diminishes teachers from having a chance to develop experiential knowledge about students as learners, about practical applications of pedagogical knowledge (like classroom management skills), and about the context of schools and communities. In the section that follows, I discuss how such deficiencies in PCK position beginning teachers to struggle in their first years of teaching.

1.3.3 From a Student to a Beginning Teacher

After finishing their courses at a university of education and passing the national examination, the students finally become public elementary school teachers. They take the 30-hour beginning teacher training course for a week in the winter before the new school year starts.[5] Ideally, pre-service teachers integrate their knowledge to become able to use their knowledge flexibly in authentic teaching situations (Davis, 2004; Linn & His, 2000). However, in this process, the beginning teachers experience a huge change in their position form “students who are learning” to “teachers who are teaching” and face many difficult situations. This is called “reality shock” or “transformation shock,” and overcoming these difficulties are essential to professional growth (Sung, 2007).

Hwang’s (2005) research on the difficulties faced by beginning teachers when they enter the first stage of the teaching profession showed that in terms of classroom management, beginning teachers have difficulty with self-confidence about their curriculum arrangements and in their lack of student control methods and consultation skills. In addition, beginning teachers lack knowledge of context about schools, including the administrative tasks required of teachers (e.g., reports, student records, parental conferences, etc.). Beginning teachers are often assigned

[5] Unlike in many Western schools, in Korea the academic school year starts in March and ends in February of the next year.

the worst administrative assignments. In an effort to hide their deficiencies, they rarely ask for help and instead attempt to complete the oppressive tasks without assistance, which can lead to feeling isolated and overly burdened. Due to expectations by senior faculty that beginning teachers should "learn the ropes", beginning teachers are reluctant to ask senior teachers for help and so they typically struggle alone. In an attempt to highlight the need for teacher education programs to provide teacher candidates more opportunities to develop school related knowledge of context, in the following section I discuss in more detail how lack of knowledge about administrative tasks puts beginning teachers at a disadvantage.

1.3.4 Doing Administrative Work

Public elementary school teachers must carry out duties not only as teachers, but also as government officials. These duties are referred to as administrative work, and it is characterized as tasks that must be completed but that are not essential to providing education in the classroom (Ministry of Education [MOE], 1981). Administrative work includes handling documentation, attending all sorts of committees, managing personnel administration and requests for cooperation by other organizations, and managing the budget and students' activity fees, etc. A 2013 Korean Teachers' and Education Workers' Union survey regarding the hours that teachers spend on doing administrative work showed that teachers spend about 30% of their working hours doing administrative work. In Seoul, 44.5% of teachers said that there are many unnecessary administrative tasks, and argued that this is a major problem in the public schools (Lee, 2013).

Administrative work is one of the things that the beginning teachers face without any notice or instruction. Many reports have shown that teachers lose time they could be devoting to educational tasks, and for beginning teachers the case is worse. Even though they are not familiar with these tasks and they could ask more experienced teachers for help, because each teacher is required to complete their own administrative work, beginning teachers are reluctant to ask for help for fear of inconveniencing others or appearing underprepared to teach. As a result, beginning teachers tend to spend more time on these tasks in the beginning of their careers until they learn ways to manage their workload.

When I first went to my school, I was embarrassed to ask for help and I did not want to reveal to my senior colleagues that I had not anticipated so much paper work was associated with teaching. Everything was unfamiliar; even the words used on the page were hard to understand. It was impossible to complete this work during the school day as teachers are expected to do. First, I tried to do the work during the ten-minute break between each period, but I could not finish before next period started. Because of this, I sometimes spent the first five to ten minutes of lessons doing administrative work. I then decided instead to try to do administrative work after the students went home, which was around 2:30 pm. Even then, I often could not finish the work during work hours, and so I needed to bring it home to finish it. Before I even noticed, I slowly began spending more of my time doing administrative work than preparing lessons.

One day before Korean class, I found that I had not even looked at the materials for the activity that the students were expected to complete that day. I was very embarrassed and did not know what to do. I replaced that activity with another one, but it was the one of the worst memories that I have of my school life. I finally realized that I was not spending as much time preparing for the lessons as I had intended to do when I was pre-service teacher. Although I was doing my best in the school, I was losing my pace in my struggle due to a situation that I had not expected at all. My teacher education program had prepared me to pass the exam process to become a teacher by focusing on my subject matter content preparation, but I felt it had done little to prepare me to complete the tasks before me each day as a real teacher. Unfortunately, this was not my only challenge as a beginning teacher. I also found that even while I had taken additional content specific courses to prepare me to teach science at the elementary level, I still struggled to teach science well. In the following section, I highlight some of the common challenges facing elementary science teachers.

1.3.5 Teaching Science in the Elementary School

Effective science teaching helps students to develop conceptual understandings and inquiry abilities necessary to be productive citizens and science learners (AAAS, 1993; NRC, 1996, 2007). Sense-making through scientific inquiry emphasizes learning conceptual knowledge and engaging in and learning about scientific practice (Anderson, 2007; Crawford, 2007; Scott, 1998). With support, young children can engage in sophisticated scientific practices and develop deep understandings of appropriate science concepts (Lehrer, Carpenter, Schauble, & Putz, 2000; Metz, 1995). Typical elementary science instruction, however, does not support students in achieving either of those outcomes (Weiss, Pasley, Smith, Banilower, & Heck, 2003).

This is because teachers often misunderstand inquiry, seeing it as linear and lockstep (Windschitl, 2003) or equating it with "hands-on" or "student-directed" (NRC, 2000)—despite the notions of the essential features of inquiry and the "inquiry continuum" that describes inquiry along a range from student directed to teacher directed (NRC, 2000). Research shows that a teachers' knowledge base needs to include pedagogical knowledge, subject matter knowledge across numerous disciplines, and PCK (Shulman, 1986) across that same range of disciplines. This includes special PCK for supporting students in scientific practices like constructing scientific explanations and engaging in collaborative activities (Davis & Krajcik, 2005; Zembal-Saul & Dana, 2000).

Research shows that pre-service elementary teachers are limited in their abilities to support students due to their own unsophisticated knowledge of some specific science topics (e.g., Atwood & Atwood, 1996; Stofflett & Stoddart, 1994) and due to unsophisticated beliefs about the nature of science (e.g., Abd-el-Khalick, 2001). Researchers have also found that elementary teachers tend to emphasize the use of hands-on activities toward the goal of engagement, interest, and motivation (e.g., Abell et al., 1998), but they do not tend to emphasize the learning of science content. Finally beginning elementary teachers often avoid teaching science altogether, or they focus on using science activities that are manageable and predictable (e.g., Appleton & Kindt, 2002).

Like most elementary teachers, I was expected to teach multiple subjects, including language arts, mathematics, social studies, and science. Of all of these subjects, I felt confident that my coursework provided me a broad overview of the content knowledge I needed to teach my class. However, at the elementary level teachers are responsible for three very different content areas – life science, physical science, and earth science—and they are expected to teach this content by engaging students in authentic scientific practice using inquiry teaching methods. As a beginning elementary science teacher, I felt I had taken sufficient coursework to expose me to most of the content we were expected to cover, but my knowledge of this content was not very deep. In addition, I lacked the practical experience needed to help me develop a knowledge base for helping my students develop coherent knowledge of science concepts and practices that would enable them to become scientifically literate citizens (Davis & Smithey, 2009). Unfortunately, this situation is not uncommon among beginning teachers and many actually struggle with subject matter content knowledge as well.

Kwak (2011) did research exploring the real situation of the elementary science classroom. In this research, Kwak found that in elementary science teaching, teachers themselves tend to have science misconceptions and insufficient science content knowledge. In her research, experienced teachers argued that it could be hard for elementary teachers with lack of science content knowledge to provide their students with meaningful science learning experiences. She suggested ways to improve in-service teacher training, such as designing supplementary in-service training focused on content knowledge for elementary school teachers based on real classroom situations which provide the opportunity for "doing science," setting up professional exchange or collaboration between primary and secondary teachers, and introducing subject-specialized teachers for fifth and sixth graders in elementary school.

As those results show, teacher education programs in science tend to emphasize the textbook content and not practical experience. Kim et al. (2011) compared secondary teacher preparation programs in Korea and the United States (Figure 1.2) and found that teacher preparation in these two countries tends to emphasize different domains of teacher knowledge.

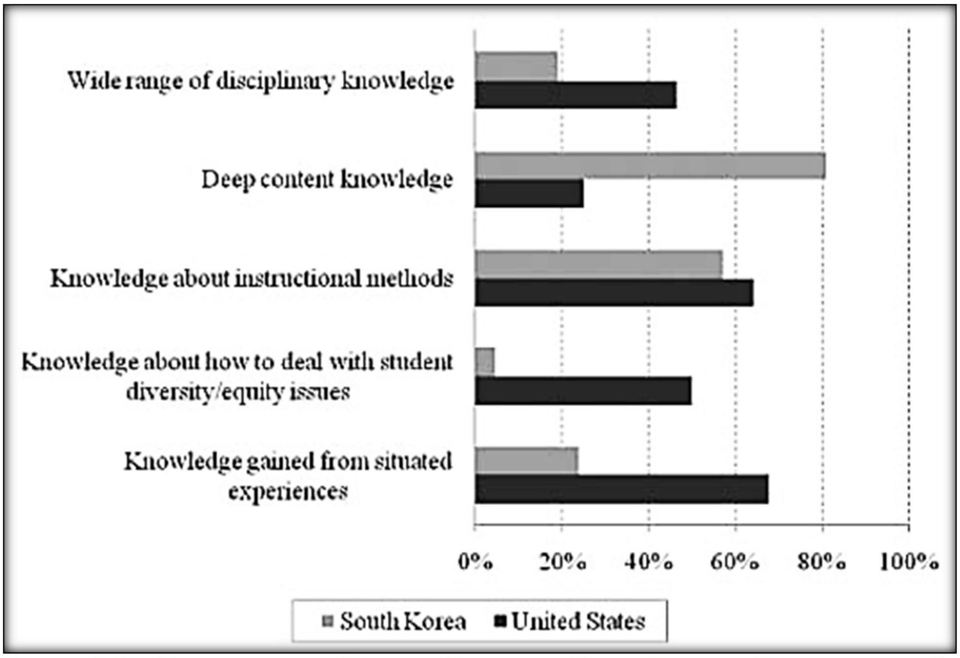

Figure 1.2 Percentages of secondary mathematics teacher preparation programs whose official educational aims mention different key ideas about teacher knowledge (Kim et. al., 2011)[6]

Korean teacher preparation programs put the great emphasis on developing deep subject matter content knowledge, but place little emphasis on developing general pedagogical knowledge, experiential knowledge, or knowledge of students as learners (e.g., meeting the needs of diverse learners). One possible explanation may be that Korean programs tend to assume that teachers' strong content knowledge can be applied in practice (Kim et. al., 2011). This assumption appears to bolster the societal expectations for "scholar teachers" (Leung, 2001) who are expected to develop rigorous subject matter knowledge.

On the other hand, more than three-fifths of U.S. teacher preparation programs emphasize the need for teachers to gain knowledge can from situated

[6] From Kim, R.Y., Ham, S. –H., & Paine, L., W. (2011). Knowledge expectations in mathematics teacher preparation programs in South Korea and the United States: Towards international dialogue. *Journal of Teacher Education*, 62(1), 48-61.

experiences, such as teaching practicums. This appears congruent with their assumption that prospective teachers need to be provided with sufficient opportunities to learn in school settings where they can make connections between theory and practice. This contrasts with Korea, where less than one-quarter of the programs mention the need for situated learning experiences (Kim et. al., 2011). These results show that teacher preparation programs in Korea emphasize content knowledge, but do not support teachers to be ready for teaching in the real world. This was certainly my own experience as a beginning teacher where I struggled to effectively engage my students as learners and where I struggled to implement instructional methods, like inquiry, which I had learned about in theory but had not experienced as a student or a teacher. In the sections that follow, I describe in more detail how my deficiency in these areas prevented me from effectively teaching science.

1.3.6 Struggling as a Beginning Teacher in the Science Classroom

Unlike at the secondary school level, in the elementary level there is more time and opportunity to help students to develop positive scientific attitudes and scientific habits of mind because there is less pressure to prepare students for college entrance exams. So teachers at the elementary level are encouraged to teach in such a way that students have positive experiences and they develop scientific attitudes in addition to gaining science content knowledge (Hong, 2008). As a science enthusiast, I also agreed with the idea of providing more opportunities for students to increase their interest in science through hands-on activities or experiments, so I tried to plan experiments and extra activities for the students in my classroom.

Elementary schools in Korea are commonly equipped with a special laboratory room dedicated to science activities. In addition, we are able to conduct small activities and demonstrations in our classrooms. Before any experiment, I always visited the science material room to do a pre-experiment and to check on the materials. I also asked for tips about the experiments from the laboratory assistant teacher at our school, who was in charge of managing the materials to be used in labs and helping teachers prepare for science lessons. She said that during the three years she had been working in our school I was the first teacher who carried out every experiment in the textbook and even completed extra experiments and demonstrations in science class. I also sought advice from other teachers, asking them how they conducted their lessons so I could learn about strategies they used in their science classes. However, I found that many of the teachers had a hard time teaching science, so they preferred to only conduct demonstrations of the science phenomena rather than engaging all students in the activities. In addition, many teachers simply showed videos of different experiments so they could present to students only ideal results.

Research (Nam, 2012) analyzing the emotional states of beginning teachers in science class found many newly appointed elementary teachers felt anxiety in their science classes and attempted to either avoid the subject or solve this problem by relying on the internet to find “fun and easy” science activities. It seemed many of my peer teachers relied on similar methods to relieve their anxiety about science teaching. Even though I faced many challenges, I wanted to teach science well and wanted to engage my students in interesting and educational activities. Unfortunately, I faced many setbacks and had many questions about how to improve my practice. I often found I had no one to ask for help and I had few ideas about how to solve my problems on my own.

Kim et al., (2010) did an inquiry into beginning teachers' experience of teaching and found that beginning teachers' teaching ability improvement involves three steps. The first is facing unexpected problems. The second is trial and error, and the last step is finding one's own way through analyzing and trying to solve the problem. Every issue that occurs in the elementary school is harder for beginning teachers. Even when beginning teachers face unexpected situations, there is no way other than to go through them and learn by trial and error. In using the process described above, teachers spend a great deal of time solving their own problems (Oh, 2005).

As a beginning teacher, I also struggled in my classroom. I had many plans for my students and since I was especially enthusiastic for science I planned many ways for my students to experience science and do inquiry themselves. But the real situation was much different from what I expected. I could not manage the students, not only in science class but also in all of my classes. I had to teach more than seven different subjects and I could not focus just on the science, so I reduced the activities for my students. As a result of my changing the curriculum, students became more confused about what they were supposed to learn because they were not familiar with doing science because it was not taught often in their previous classes.

I knew that I needed to do something in order to improve the teaching and learning of science in my class and I was desperate to try anything that might work. Coincidentally, during my first year of teaching, I was also enrolled in a graduate level course in science education focused on engaging teachers in action research projects to solve problems in their own classroom. In this course, I was introduced to many helpful theories and methods to improve my science class. Learning about theory while being a practicing teacher meant I had the opportunity to put into practice some of the things I learned about at university. My thesis research stems from this earlier work utilizing action research. In the following sections, I define the purpose and context of the research.

1.4 RESEARCH QUESTIONS

1.4.1 Purpose and Focus of the Research

Currently, there is limited research about beginning elementary science teachers in Korea and the methods they can use to develop their PCK to improve their science teaching. Conducted within the methodological framework of action research, this research examines the ways in which beginning teachers can engage students in collaborative research efforts with her students to overcome the isolation beginning teachers experience and to work individually and collectively to resolve problems in classroom teaching and learning. Specifically, this study introduces a qualitative research method called cogenerative dialogue (coupling video analysis and structured discourse between teachers and students) to develop targeted domains of teacher PCK, including knowledge of students as learners, knowledge of how to manage the classroom (especially during inquiry science activities), and how to effectively implement inquiry instructional strategies in the elementary classroom.

To improve my PCK about students as learners, I thought it was essential to invite my students to participate in my research and for us to try to improve science teaching and learning together in our own classroom. Thus I started an action research project in which I engaged students in my 5th grade science class as co-participants to help me transform my class teaching practices. To date, considerable research in the field of science education has shown that cogenerative dialogue is a powerful tool for helping teachers and students to build relationships that provide them a chance to talk about school and science class in an effort to improve teaching and learning. While many studies have used cogenerative dialogues and discussed their benefits, no studies have examined the process of cogenerative dialogue in conjunction with teacher development of PCK. In addition, no research has examined the effectiveness of action research by a beginning teacher using cogenerative dialogue in to improve science teaching in a Korean elementary classroom. For these reasons, in this study, I examine the effectiveness of using cogenerative dialogue as part of a collaborative action research project and, specifically, I explore how this tool helped me to develop targeted domains of my PCK that serve to improve my science teaching.

1.4.2 Research Questions

The following questions guided my research:

1. What can teachers and students in elementary classrooms learn from one another by engaging in cogenerative dialogues?
2. How can what teachers learn from cogenerative dialogues enable them to improve science teaching and learning to improve PCK?

1.5 CONTEXT OF THE STUDY

1.5.1 My School

J[7] elementary school is located in an urban area in Seoul, Korea. As this area changed from a residential to a commercial district, many people left and a poor neighborhood has formed around the school. More than 15% of the students are considered to be from families classified as low socio-economic class[8]. The school has been designated as an "education welfare-special invested school" since 2009. An education welfare-special invested school is a school receiving government support for educational welfare[9]. There are 353 education welfare invested schools in Seoul and 156 of them are elementary schools. The total number of elementary schools in Seoul is 597, so about 26% elementary schools are supported for educational welfare.

A school's eligibility for this program is determined by certain standards, for example the number of the students who are recipients of basic living subsidies and the number of students who are from multi-cultural families who need support[10]. If a school is designated as an education welfare-invested school, the school can designate a portion of their budget to support students' needs in a variety of ways. For example, the money can be used for field trips, for vouchers

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7 In this study, I use pseudonyms for the school and all students to provide anonymity for the participants. In addition, measures are taken to protect the identity of students in offprints of photos from the video by obscuring the faces of participants using photo-editing tools.

8 A student may be classified as being from a low-socioeconomic level if the family's income is lower than certain standard set by the government or if the child is from a family in which one of both of the parents do not exist (single-parent home or orphan).

9 Educational welfare includes enhanced academic supports, culture experiences, counseling, emotional care, and support from community.

10 In Korea, a multi-cultural family is usually defined as a family where one or both of the parents are not Korean. These families often live in poverty due to limited job opportunities and education and due to cultural and linguistic challenges.

for taking after-school programs, and for students to take a psychological aptitude test and have a chance to talk with professional counselor. In my class, there were five students among twenty-five students who were designated as the students who needed additional supports.

1.5.2 Overall Student Achievement and Demographics

In our school, overall student achievement is very low. Student scores in Korean, Math, and English in the Korean Standard Assessment Test 2011 were almost the lowest in Seoul. Our school ranked 419th in 2011 and 407th in 2012 among about 580 elementary schools in Seoul that took the test (private communication with school administer, September 2012). The school houses grades K-6, with the total number of students in the school shown in Figure 1.3.

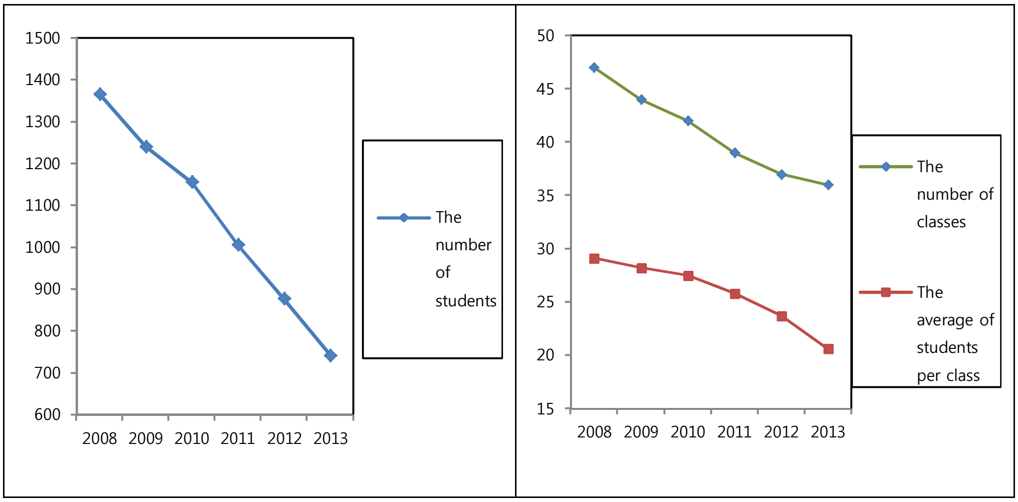


Figure 1.3 The number of students, classes, and average number of students per class

The decreasing class size is due to decreasing Korean student population (Seoul Metropolitan Office of Education [SMOE], 2008-2013). In general, our school is becoming less and less populated each year. At the lower elementary levels, there are fewer classes for each grade level than at the upper elementary levels.

1.5.3 My Classroom

My fifth-grade class consisted of 25 students, 16 boys and 9 girls. One of the students was a multi-cultural student whose mother was Japanese. There were seven students who scored lower than 60% in science at the beginning of the school year, and four of these seven students also scored less than 60% on the final science exam in the first semester. On average, students scored about 76% and 15 students scored above average. Students had 22 class periods of instruction each week and each lesson was 40 minutes long. The homeroom teacher teaches almost every subject. Science class is taught three times a week. Science classes normally took place in the classroom or in a special laboratory room, depending on the content to be taught.

1.6 OVERVIEW OF THE THESIS

1.6.1 Chapter One

In the first chapter, I begin with a description of being a public school teacher and the difficulties the beginning teacher faces. This problem is situated within the context of the relevant literature that depicts the many difficulties facing beginning teachers, especially with regards to deficiencies in PCK. I introduce PCK as an analytical lens for identifying aspects of my teaching practice that needed to improve. In addition, I briefly introduce the context of the study and I delineate the purpose and the questions of the study.

1.6.2 Chapter Two

The second chapter describes the methodological framework for the study. This study was conducted as a type of action research using a qualitative method known as cogenerative dialogues. In this chapter, I describe teacher action research and the need for teachers to engage students as co-researchers to address certain domains of PCK, including knowledge of learners. I introduce and describe the theoretical and methodological underpinnings of cogenerative dialogue and I detail which data sources are used and how data was collected and analyzed. For the purpose of this research, I focus video and audio analysis at meso and micro levels to make sense of how my engagement in cogenerative dialogues with students supported me to develop my PCK.

1.6.3 Chapter Three

In Chapter 3, I use Guba and Lincoln's (1989) authenticity criteria as a framework for tracing my changing PCK in the first stage and second stages of the cogenerative dialogue process. In this chapter, I describe the conversations we had and the ideas that students suggested in cogenerative dialogues and I analyze how our application of individual and collective ideas positioned me to develop as a teacher. Specifically, I pay attention to the role of shifting ontologies as a result of listening to and learning about my students. I came to realize I'm not the only one responsible for making science class successful, as my students should also be active participants in their own learning. In addition, as I witnessed my students begin to change learning practices in the science classroom, my PCK of learners was greatly expanded – which had a powerful affect on my teaching practices as I began to share more responsibility with students for how science was taught and learned in the classroom.

1.6.4 Chapter Four

Using Guba and Lincoln's (1989) authenticity criteria as a framework for tracing my changing PCK, Chapter 4 examines what I learned as a result of my analysis of the catalytic and tactical steps of the cogenerative dialogue process. This chapter examines how our ontological and educational shift affected the ways in which we improved the science class by urging us to be catalytic and, when possible, wary of the need to be tactical. In this chapter, I also highlight some of the difficulties that my students and I faced during the research.

1.6.5 Chapter Five

In the concluding chapter, I re-examine the findings of this study and I offer implications for policy, teacher education, and researchers about how to better support beginning teachers to continue to develop their PCK once in the classroom. Finally, I suggest the ways in which teacher education programs can help beginning teachers struggling in their own classrooms by doing action research using cogenerative dialogues. I also emphasize what aspects of cogenerative dialogue are most helpful to both teachers and students.

1.7 CONCLUSION

In this chapter, I described the challenges faced by beginning teachers in elementary school and science classrooms in the Korean context. I also introduced the concept of PCK, pedagogical content knowledge, which will be used as a theoretical framework. I have tried to highlight the challenges beginning teachers face and make the connection between that and PCK.

In the following chapter, I will describe this action research methodology and how it was used to support me to change my teaching practices, as well as why I think it is especially effective for beginning teachers.

Chapter 2

Methodological Considerations

2.1 INTRODUCTION

I have a strong belief in the responsibilities of science teachers. First, science teachers must have sophisticated content knowledge of science in order to prevent students from having misconceptions or misunderstandings. Second, an elementary science teacher especially must provide many opportunities for students to experience science in order to help students to develop positive scientific attitudes and scientific habits of mind as opposed to just giving the science. However, teachers' PCK consist of many different domains of knowledge, meaning that to be successful, they must master not only the subject matter knowledge but also other forms of knowledge, such as general pedagogical knowledge.

General pedagogical knowledge includes knowledge about classroom management or knowledge of learners is essential in the classroom; however, the pre-service teachers have limited chance to develop their PCK in these domains and beginning teachers find they are often isolated in their teaching, spending time only with their students and having limited opportunities to engage in professional development with peers. As a result, many teachers find that they themselves have to solve their own problems by trial and error.

In this chapter, I'm going to introduce a research methodology designed to support teachers to learn how to improve their own teaching in a more systematic way than just "trial and error". In the following sections, I lay out the methodological framework that I used in my research and I explain how I combined aspects of learning as a social activity, participatory action research, and cogenerative dialogue to create an approach to research that was both meaningful to me and transformative for my PCK. In so doing, I describe the actual research in more detail and make clear the connections between the methodology and the theory employed to frame my interpretation of the study.

2.2 METHODOLOGICAL FRAMEWORK

2.2.1 Learning Science via Inquiry

Since the late 1990s, in Western countries and in countries influenced by Western educational systems, there has an imperative for science lessons to be based on student-centered approaches and active teaching and learning (Mortimer & Scott, 2003). Mortimer and Scott (2003) described the changes in the science education like this:

> Teacher and students are now out of their seats, working alongside each other, involved in a whole range of different kinds of hands-on practical activities. Compared with what earlier generations of students experienced at school, today's science lessons are virtually unrecognizable. (p. 1)

In their book, there is a great emphasis on the emotion on the learners. They argue that, "the affective and emotional aspect of teacher-student and student-student relationships is very important in the process of teaching and learning science" (Mortimer & Scott, 2003, p.16). These quotes make clear how complex the issue of "good science teaching" can be.

Currently many science curricula require that students engage in activities that involve inquiry learning and group interactions as a way to improve students' problem-solving abilities and interest in science. These trends are largely influenced by research, such as that by Lev Vygotsky, asserting that for students to effectively learn science, they should be engaged in learning as a social activity. The national Korean science curriculum (MEST, 2008) states that the goal of science education is to develop students' scientific literacy through understanding the basic concepts of science, increasing students' ability to engage in scientific inquiry, improving students' attitudes towards science, and preparing students to solve problems creatively and reasonably.

Even though the Korean national curriculum and nationally developed textbooks emphasize inquiry, the majority of teachers in Korea do not have a lot of personal experience engaging in these types of learning activities. In my own experience, because I specialized in science for the elementary school, I had the chance to take two intensive laboratory courses, which totaled five credits. During those courses we had opportunities to conduct some of the experiments that are to be introduced in the elementary level curriculum. However, we did not have enough time to cover every experiment, so we just completed selected activities. Due to time constraints, it was hard to fully experience or talk deeply about inquiry. As a result, teachers in Korea are expected to teach science using inquiry instructional strategies even though we have hardly experienced inquiry in our own lives.

This is another example of how teacher preparation programs in Korea do not adequately prepare teachers in all of the PCK areas. Knowledge of instructional strategies should include not only academic knowledge, but also practical experience. In addition, because teacher education programs and previous K-12 educational experiences do not offer opportunities for teachers to learn science through inquiry, teachers also lack personal experience in engaging in inquiry science learning. This meant that as a new teacher, I lacked not only PCK regarding knowledge of learners, but also PCK regarding how to effectively utilize instructional strategies to teach science from an inquiry perspective. And while I had been exposed to the concept of inquiry through course lecture and readings, I had very limited practical experience engaging in inquiry as a learner.

My need to develop an expanded understanding of students, to improve my use of instructional strategies, and to reflect on my use of inquiry in the classroom encouraged me to seek help. In the following section, I describe how my desire to improve my science teaching in the elementary grades led me to conduct research in my own classroom using participatory action research.

2.2.2 Action Research

Teaching is not just a matter of learning and applying knowledge and skills that have been prescribed by experts. Rather, it is a matter of deploying, criticizing-in-action, and developing-in-action a complex and unique framework of personal professional understandings (Barnett & Hodson, 2001). As a graduate school student, I took a course entitled "Science Teachers as Researchers into their Own Practice" where I first encountered the research methodology called *action research*. Mills (2000) defines action research as, "Any systemic inquiry conducted by teacher researchers, or other stakeholders in the teaching/learning environment to gather information about how their particular schools operate, how they teach, and how well their students learn" (p.20). Action research is research done by teachers for themselves and it is a process of studying a real school problem or situation. The goal of action research is to improve teachers' teaching and to enhance classroom learning or how a school functions. Pedretti and Hodson (1995) have argued "action research gains much of its potential for effecting change by creating new social settings for teachers" (p.15).

Many other researchers and teachers have done action research to improve science classes. However, most of the research was done only from the teachers' perspectives. I did a small action research project during my first semester as a teacher to explore how to improve achievement for low-achieving students. I made extra worksheets for the low-achieving students in my class to provide them a more structured resource to help them be successful during class. I felt like these worksheets were working effectively as they helped the students to become more involved in my lesson. However, when I asked the students whether it was helpful or not, they did not answer, "Yes." I was surprised by their answer.

What this experience taught me was that the effectiveness of action research can be limited if teachers do not adequately engage students in the research process. I decided to change my teaching practice in an effort to improve student involvement, but the decisions I made were not based on any input from students. Learning that my students held a different perspective about the changes I made in the classroom made a big impression on me as a researcher. It was only later, once I engaged these students in a new action research project that included students' perspectives, that I found out the reason why the students did not reply positively about the changes I made. I expand on this vignette in the following chapters, but first I want to more fully discuss the concept of engaging students in research as more than just research participants.

2.3 PARTICIPAROTY ACTION RESEARCH

2.3.1 Engaging Students as Researchers

Because I had come to believe that my students had something to tell me about how to improve the classroom, I knew I wanted to engage my students in helping me address the problems in my classroom. So in order to do that, I decided to utilize participatory action research, which means that my students as would participant as researchers in my project. I had become aware of a methodology from science education research that suggests that any teacher can do a type of research with their student called *participatory action research* (e.g., Tobin, Seiler, & Elmesky, 2005; Stith & Roth, 2008). Participatory action research is by, with, and for people affected by a particular problem, which take places in collaboration with academic researchers. It seeks to democratize knowledge production and foster opportunities for empowerment by those involved (Kindon, Pain, & Kesby, 2009). Seiler and Elmesky (2007) found in their research that involving students as researchers is a crucial component of conducting research that looks at the improvement of science teaching and learning.

Typically, action research is where a teacher undertakes a project in her/his own classroom to improve teaching and learning. This is somewhat different from participatory action research, because I wanted both my students and I to act as co-researchers in the action research where we would work collectively to identify the issues and resolve them. Many researchers who did research with students to improve science teaching and learning used a method called *cogenerative dialogue* (Martin, 2005; LaVan & Beers, 2005). In the following section, I will provide more detail about cogenerative dialogue.

2.3.2 Cogenerative Dialogue

Cogenerative dialogue (LaVan, 2004; LaVan & Beers, 2005; Roth & Tobin, 2001; Wassell, 2004) is a discussion between stakeholders that examines shared events and experiences. Cogenerative dialogue provides a neutral field in which participants examine the conscious and unconscious parts of structure (Sewell, 1992), such as schema and practices, which afford agency in the field of the school or classroom. A critical component of cogenerative dialogue is that participants share responsibility for examining and creating change in the classroom.

Cogenerative dialogues can occur in both formal and informal ways. Formal cogenerative dialogues in a school setting usually occur either during or outside of class time. These take place between a teacher and an entire class of students during or after instructional periods. However, more cogenerative dialogues take place in small-group settings between a teacher and a group of students outside of instructional time, such as during break time or lunchtime or after school (Martin, 2006a). Informal cogenerative dialogues often occur as issues arise, and these conversations are not limited to occurring within the school setting or in small-group formats (LaVan, 2006).

Through cogenerative dialogue, students and teachers can discuss power relationships and the roles of participants (Seiler, 2002) as well as consider individual and collective activity, goals, roles, equity issues, curriculum, and responsibility. The notion of shared responsibility is central to these discussions, as participants reflect on shared experiences, power relationships, and the differing roles and perspectives of all those involved (Martin, 2006b). Shared perspectives are used to inform the emerging understandings of classroom interactions, the quality of these interactions, participant practices and how these patterns of interactions contribute to the accomplishment of the collective activity of teaching and learning science.

Cogenerative dialogues provide a social space for teachers and students to become actively involved in thinking about and making changes that are important to their particular classrooms and schools, they have been used methodologically to help researchers collect data about science teaching and learning (Wassell, 2004; Olitsky, 2005; Martin, 2005). Through participation in cogenerative dialogues, students develop new ways of interacting with adults and their peers (LaVan & Beers, 2005). Martin (2005) noted that as students learned how to get their points across to others, teachers began to understand their teaching practices through others' eyes and to more effectively listen to students' concerns. Additionally, research has shown that through repeated cogenerative dialogues, teachers learn how to explain their perspectives and choices. These conversations among participants are crucial in raising consciousness about different participant perspectives, providing a means of addressing social reproduction by examining sites for both successful and failed interactions which can then be transformed to improve teaching and learning (Martin, 2005).

Conversation with students can be a tool that allows a teacher to develop from PCK readiness about the knowledge of the science learner and science inquiry towards really being able to do science. Because I wanted to learn about students and to better understand how to use different science instructional strategies, I decided to engage my students in action research using cogenerative dialogues to discuss some issues in our class. To examine the effectiveness of cogenerative dialogues, I used the PCK framework to trace my development as a result of my participation in this research. Other researchers (Martin, 2005; Martin, 2006c;

Martin & Scantlebury, 2009) who previously used cogenerative dialogue have used Guba and Lincoln's authenticity criteria as the methodological framework to guide and support to their research. In this study, I also use cogenerative dialogues framed by Guba and Lincoln's authenticity criteria. In the next section, I will expand on Guba and Lincoln's work because it is central to my research.

2.4 AUTHENTICITY CRITERIA

An important issue for qualitative research is that of authenticity. Authenticity involves shifting away from concerns about the reliability and validity of research to concerns about research that is worthwhile and thinking about its impact on members of the culture or community being researched. Authenticity, then, is seen as an important component of establishing trustworthiness in qualitative research so that it may be of some benefit to society (James, 2008).

Guba and Lincoln (1989) described a set of authenticity criteria that serve as measures by which we can judge the validity and quality of the qualitative research. In this research, the authenticity criteria serve as different steps for me to engage students in the process of cogenerative dialogue. I look at how each of the different steps of the process can support me to learn about different aspects of my PCK. The four authenticity criterions are ontology, educative, catalytic, and tactical. Table 2.1 shows the meaning of each step as characterized by previous cogenerative dialogue research (Martin, 2005) and describes how these criteria help to shape each phase of the process that teachers and students engage in while conducting cogenerative dialogues

.

Table 2.1 Components of authenticity criteria and steps used in the research

Authenticity Criteria	Meaning	Step
Ontology	Everyone learns from each other	Teachers need to invite a diverse group of students to participant. Ask for volunteers or request individuals to participate.
Educative	Learn and teach one another	Everyone has a chance to speak but no voice is privileged.
Catalytic	Should make a positive change	All cogenerative dialogues should be conducted with a goal of collective suggestions and cogeneration of a plan of action to make a change in teaching and learning
Tactical	Assist all individuals to benefit from the research	We argue to individually do our part to enact the change and come back to check in and see how it worked.

Ontology means expanding their individual constructions of the world. Tobin (2006) explained that ontological authenticity relates to the ways in which participants in the study alter their perceptions of the nature of social life, as it pertains to the research. This step was really important because I invited students in order to learn from students. I wanted to learn about not just one type of students, but lots of different students. Educative means that we have to talk to each other and listen to each other so we are educating one another. I wanted to understand what 5th graders thinks about, whether they enjoy science class, and whether they had feedback about my use of different instructional strategies. But I also needed to learn how to improve my classroom management skills. The third step is the catalytic phase. Catalytic means that we have a responsibility to enact changes in our practices based on what we learned from one another in the previous phases. An example of me being catalytic is for me to implement some new practices regarding my classroom management skills and also my science teaching based on student feedback. The fourth step of this process is really difficult and really interesting. Tobin (2006) talks about tactical authenticity, saying that researchers have an obligation to help the participants who are unable to help themselves by providing additional structures for those individuals for whom the efforts to educate them and catalyze worthwhile changes were not enough (pp.28). So if I really value that we are learning from each other, I also need to recognize that meeting the tactical authenticity criteria is sometimes too difficult for me to do.

In following section, I introduce how I conducted the research and the ways that I collected and analyzed data. In following chapters, I describe the evidence of improvement in my PCK following each phase of the process I engaged in and offer my reflections about the role of the authenticity criteria in shaping my practices.

2.5 DATA COLLECTION

I first began teaching at this school in November 2011 when assigned to take over a class for teacher who had quit the school. In March 2012, I started my first full year at this school and began teaching the students with whom I did my action research projects with over the entire academic school year. After having the first small action research (briefly introduced previously) I began a second action research project involving all of the students in my class in Fall 2012. This project is the main focus for my thesis.

During the 2012 academic school year, I had my first experience as a homeroom teacher. Because I had specialized in science, I generally spent more time planning for my science lessons than for the other subject areas so I anticipated these lessons would be more successful than some of my other lessons. But contrary to my expectations, I had many difficulties managing my students during activities, engaging students in inquiry activities, and understanding how my students made sense of the concepts I was teaching. As a result, I decided to expand my use of action research from the first semester to improve the science teaching and learning situation with my students.

2.6 DATA SOURCES

The data were collected during one half of the academic school year[11]. The data sources included video and audio captured from science lessons, cogenerative dialogues, one-on-one and small group interviews, field notes from both teacher and students, learning environment surveys, and transcripts from video and audio of science lessons.

2.6.1 Video

During every science class and laboratory period, cogenerative dialogues were videotaped either by a university researcher, a teacher, or from a fixed position in the classroom. The university researchers included my thesis adviser Sonya Martin, and a doctoral student in my lab, Jennifer Park, who each served as video recorders and also engaged in some analysis of the video. It was expected that the students

[11] While data was collected during the entire 2012 academic school year, first for the action research project to improve student achievement for low achievers and later with the whole class to improve science teaching and learning. Data for both projects was similar.

might be wary of the university researchers, so they would often arrive at the school a period before class and/or remain for a period afterwards in order to talk with me and the students about the class or have lunch together with my class. In an effort to establish trust between the students, Martin, Park, and me and to solidify their presence in the class as participant observers (someone who the students learned to see as a resource for their learning), we made a conscious decision to forego videotaping the class for the first few classes of their involvement in the class.

The classes were usually recorded from varying positions within the classroom depending on the particular activities and questions that needed to be answered that day. Martin and Park used a handheld camera and traveled all around the room to capture different interactions, often zooming in on groups of students or me as I worked with different students. 28 days of the school year were videotaped or audiotaped resulting in about 56 hours of data resources including 3 whole class cogenerative dialogues, and 3 group cogenerative dialogues, and 2 individual cogenerative dialogues.

2.6.2 Audio

In addition to being videotaped, many of the cogenerative dialogues were audiotaped by placing a recorder with a flat microphone on the desk in the center of a group of students. Audiotapes were used to record interviews with students conducted by Martin or me in both formal and informal discussions about class and home life.

2.6.3 Field Notebook

As a teacher-researcher, I did not have time to take detailed notes during the science class because I was teaching, but I did keep field notes, writing about the lessons before each class and reflections of the lessons after every science class and also after cogenerative dialogues. Figure 2.1 shows the field notes that I have used during the research. They were written in Korean or English. The reflections were written in Korean mostly to describe my emotion more in detail.

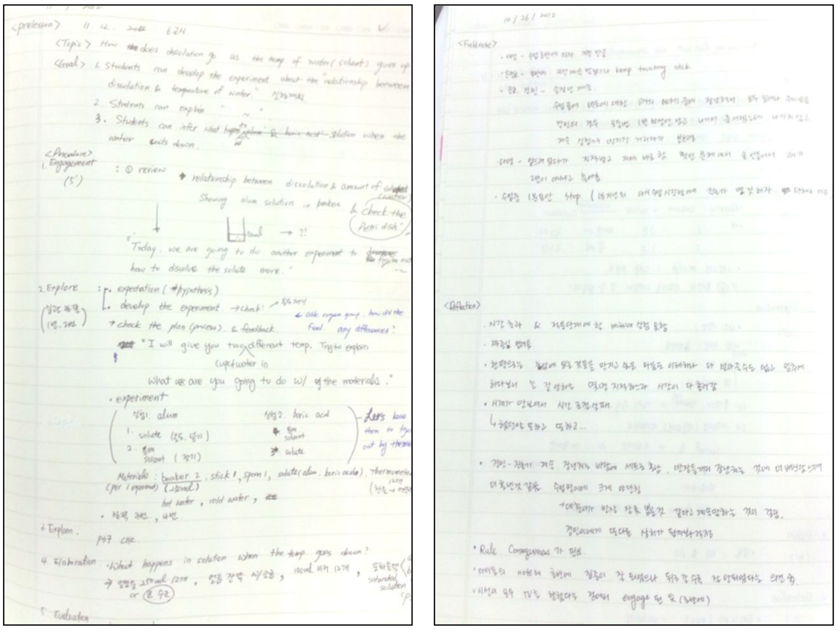


Figure 2.1 The field notebook of lesson plans and reflection

These notes often serve as placeholders for video resources indicating the dates on which we can review specific classes and interactions of interest. As a university researcher, Martin's detailed field notes of her observations, reactions, and questions also served as a data resource.

2.6.4 Student Research Notebook

In order to gain perspective about what it is like to be a student in my classroom, it was crucial to include students as researchers. So every student had their own research notebook and wrote the short reflection about each lesson and ideas or suggestions (See Figure 2.2).

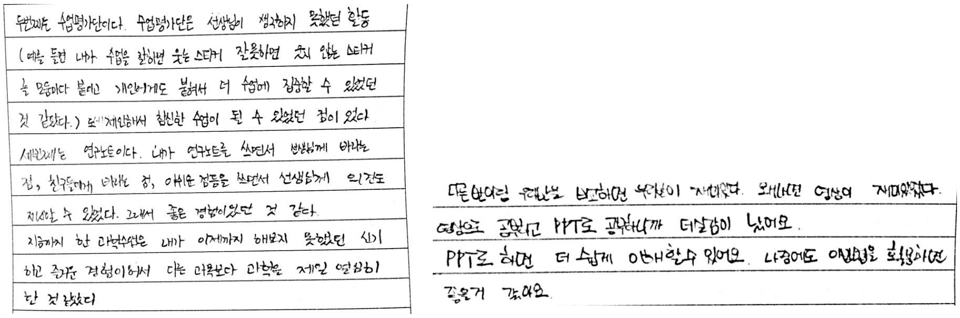


Figure 2.2 Students' research notebooks

2.6.5 Cogenerative Dialogue

I built several different types of cogenerative dialogues in my research. The whole class engaged in cogenerative dialogue after science classes. Students could talk freely or use their own research notebook. I did small-group cogenerative dialogues to make plans for our science classroom and I did some one-on-one cogenerative dialogues with students after school or science class. Mostly they were low-achieving students or students who showed dramatic changes in attitude during the lesson. Including whole class, group, and individual cogenerative dialogues, total of 7 cogenerative dialogues were video- or audio-taped.

2.6.6 Research Meetings

My thesis adviser, Dr. Martin, and I had a regular meeting once a week. We discussed the research that was done that week and exchanged ideas and tried to make progress with the research. Martin was the professor for the class where I encountered action research. She gave me very helpful advice and ideas to apply for the next classes. The research meetings were also audiotaped.

2.7 METHOD OF DATA ANALYSIS

The point of this research was as a beginning teacher I wanted to engage elementary students in a participatory action research project using a method called cogenerative dialogues. The goal of this research was to understand what elementary school students and teachers learn and to improve my PCK as a result of that. The approach for analyzing this data is different for each of these questions. For my first research question, I looked closely at each of the step of the cogenerative dialogue to identify which were around issues of PCK to identify what students and teachers understood in the four steps of authenticity criteria.

In this time, to analyze this data, I watched each of the videos in normal time. These observations helped me to understand what was occurring in the classroom and to describe interactions between students and me during classes and to develop a broad understanding of class activities and engagement patterns. And when I found small bits of data that were interesting or that seemed to demonstrate student's belief or thoughts, then I edited that video into smaller segment and examined it more closely and I transcribed it. I gained a greater understanding of how the practices and interactions observed at the classroom level are affecting interactions with students and science teaching and learning.

2.8 CONCLUSION

In this chapter, I tried to describe the methodological framework that underpins my research and introduced the data of my research, context, resources, and analysis. Specifically I introduced the concept of action research and the value of engaging participatory action research with my students. I introduced using a method called cogenerative dialogues as a way to examine what students and teachers could learn at the elementary level by engaging in this type of research. By analyzing student and teacher interactions at each step in the cogenerative dialogue process framed by authenticity criteria, I hope to gain some insights into my students as learners and about my own instructional strategies, both of which can improve my science teaching.

In following chapters, I will show the results of my research by referring to my research questions. In the next section, I will provide more details about who my students and how I engaged them in cogenerative dialogues.

CHAPTER 3
LEARNING FROM ONE ANOTHER

"Wow, it works. Honestly, I doubted the change. But it works!"

(HS, personal communication, October 2012)

HS is a student who participated in every group cogenerative dialogue and suggested ideas very actively. He was one of the students who participated in my first action research project about how to improve achievement for low-achieving students during my 1st semester teaching his class. He lived with his father in a welfare center and was also one of the students who received support from the school (including supplies, funds for field trips, and vouchers for after-school programs). He liked to talk with teachers and he often came to my desk to talk about his daily life and thoughts. The above quote is from a brief conversation we had after applying the new rules in our science class that we had cogenerated during our second cogenerative dialogue.

Immediately after science class, HS came to me while I was cleaning my desk and getting ready for the next class. His face was flushed with excitement and joy. At that time, I was also really excited since I could also see that the changes and the plans we had cogenerated were working. However, the feeling that I had after knowing that one of the students was convinced that our efforts were truly valuable was more than just happiness. I will never forget his face and the feeling that I had after our conversation. It was a precious moment for me when the small doubts I had about the process changed to conviction! It was also a moment when I realized that my participation in the cogenerative dialogues was expanding my understanding about how my students thought about our class, my teaching practice, and their role as learners. As a result, my PCK about 5th grade students as science learners was developing – and those insights are important tools for me today as I think about how to structure my classroom activities and how to more successfully interact with my students.

3.1 INTRODUCTION

In the previous chapters, I described the challenges that beginning teachers face and the problems that I had in my own classroom, especially in teaching science. I explained the reasons why I decided to implement an action research project with my students and I introduced the theoretical and methodological lens that framed my research. In Chapters 3 and 4, I will describe how I extended my PCK through participatory action research utilizing cogenerative dialogues to structure conversations with my students about how to improve science teaching and learning. In this chapter I focus my attention on how cogenerative dialogues provided me an opportunity to develop a form of PCK known as general pedagogical knowledge (GPK).

Shulman (1987) theorized GPK to include "broad principles and strategies of classroom management and organization that appear to transcend subject matter" (p. 8), as well as knowledge about educational contexts and purposes, assessment, and about learners and learning. Other definitions of GPK include "knowledge of theories of learning and general principles of instruction, an understanding of the various philosophies of education, general knowledge about learners, and knowledge of the principles and techniques of classroom management" (Grossman & Richert, 1988, p. 54).

Thus GPK is considered a generic form of knowledge that is involved in all issues of classroom management, lesson plan development and implementation, and student evaluation and that requires an understanding of cognitive, social and developmental theories of learning and how they apply to students at different ages and different abilities.

Generally teachers are exposed to theories, philosophies, and content related to GPK through their course work as pre-service teachers, but many researchers, such as Schön (1983) insist that GPK must be learned from practice – from interacting with students in specific classroom contexts. As mentioned previously, pre-service teachers in Korea have limited opportunities to engage in experiential teaching. As a result, many beginning teachers, including me, face many challenges with regards to GPK in the classroom. However, some researchers contend that these challenges are made worse when teachers are asked to teach specialized content areas like science. This is because teachers must integrate content specific knowledge with GPK if they are to effectively plan and implement inquiry-based science lessons. As a K-12 student and pre-service teacher, I had limited opportunities to conduct inquiry-based activities or to do laboratory experiments. So I lacked both GPK and PCK about how to effectively manage students during class and also how to manage students as they engaged in hands-on activities using laboratory equipment. Any teacher who has attempted to facilitate a laboratory activity with 25 10- and 11-year olds will know this is not an easy task!

All teachers require GPK to effectively manage the classroom and effectively teach students, but to teach science, they must also integrate many forms of knowledge that are then transformed into the PCK necessary for teaching science content at a specific grade level in specific contexts. In the sections that follow, I describe how I was able to expand my GPK by engaging in cogenerative dialogues with my students as part of our participatory action research. I focus on the first two steps of the cogenerative dialogue process, which dictate that cogenerative dialogues should be ontological and educative. In doing so, I draw attention to the ways in which this research supported me to make an ontological shift in my GPK regarding my students as learners and how our focus on educating one another about our views regarding science, how to manage the classroom, and how to effectively interact with one another, supported me to transform this knowledge into PCK about how to teach my students science.

3.2 SCIENCE CLASS BEFORE COGENERATIVE DIALOGUES

To understand the transformations that took place in our class, it is important to examine the classroom situation that existed before our participation in this research. In this section, I am going to give some vignettes from my science class and cogenerative dialogues to help illustrate the situation in my science class.

3.2.1 "Please, don't yell at us."

"I think there is a problem with the atmosphere in our science class. When the teacher got angry with us, we were quiet. But after a few minutes, it seemed like we were making noise again. We need to change this."

(JH, Class reflection in the research notebook, November 2013)

"Please, don't yell at us so much."

(JW, Suggestion to teacher in the research notebook, November 2013)

These are the words my students wrote in their research notebooks after watching the video recording of our science class during the first cogenerative dialogue. As one scene from that science class shows (See figure 3.1), I was having hard time managing my students in the science class, especially when we had class in the laboratory room. In this screenshot, I am seen ordering a student not to talk anymore by stretching my arm towards him with stern face.

Figure 3.1 Managing students in pre-cogenerative dialogue classroom

During our whole-class cogenerative dialogue, many students pointed out that in our science class that they only kept silent when I got angry and yelled at them. I was very embarrassed and felt sorry to my students for my behavior. It was difficult to hear them describe my actions.

From video analysis, I discovered that I yelled at my students more often than I thought. As the students mentioned, it was a method I used to manage my students – and even though it was not very effective, it was the only method I had at that time. A 40-minute class for one experiment was a very short time for me to help my students experience science and accomplish the purpose of the lesson. Many materials were quite dangerous and needed to be used carefully. In the laboratory, students sit facing each other, and kept chatting even while I was doing the lesson. They enjoyed the experiments and hands-on activities, so they could not wait for my directions and started to touch the materials and even fight with each other. This all occurred at once and I was really overwhelmed. My only option to make them be quiet and look at me was yelling. They then at least stopped talking and looked at me. However, they did not remain quiet or continue to pay attention, which means I had to yell frequently. This situation got worse and worse, until finally some of my students started to point it out in their writings in their research notebooks. During a whole class cogenerative dialogue, some students raised this point, which I really appreciated because this gave us a chance to correct this problem together.

In the next sections, I describe some other examples of changes in my science class practices I tried to make without input from students - especially about my teaching strategy using inquiry notebook and 5E learning model.

3.2.2 Am I Doing This Right?

Scientists work to create knowledge and understand the natural world. When scientists observe phenomena they cannot explain using existing knowledge, they become curious about these phenomena and they do experiments to find answers by collecting and analyzing data and making generalizations. The process of finding an answer to a question is called *inquiry* (National Research Council, 1996, 2000). By using inquiry in science, students can understand not only scientific concepts but also the nature of science. They can develop a positive attitude towards science as well.

The importance of inquiry was first emphasized in the Third Korean National Elementary Science Curriculum and was more strongly highlighted in the

2007 Korean National Elementary Science Curriculum[12] (Kwon et. al., 2011). In the science textbook, there is an introduction part about inquiry. Figure 3.2 is the first page of introduction chapter in 5th grader's science textbook. In this chapter, definition of inquiry and science process skills such as observation, classification, measurement, predictions, reasoning, communication, problem recognition, hypothesis, control variables, data conversion, data analysis, and generalizing are introduced.

Figure 3.2 Fifth-grade science textbook introduction of inquiry

These standards are reflected in the workbook we use in our science class. Students are instructed to write down their predictions about what will happen in the experiment prior to doing the activity. I used this workbook during the first semester. It was when we were studying the function of a plant's roots that we did an experiment using onions in which the students were asked to compare the amount of water remaining in the two cups after several days. In each of the two different cups, there was an onion with a root and an onion without a root.

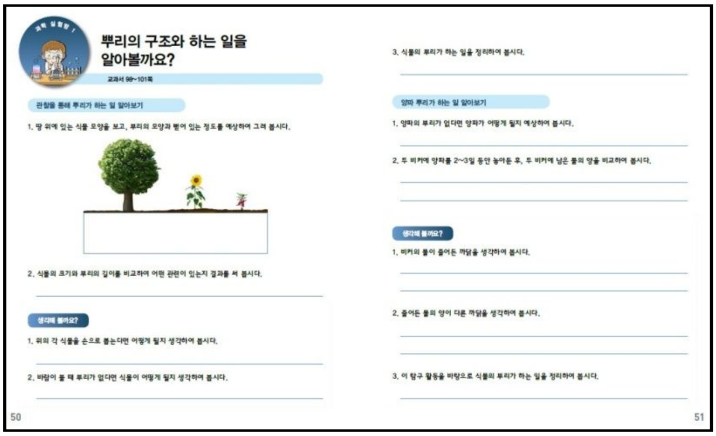
Before I started the experiment, I asked the students to write their

[12] The Korean elementary science textbook is a government-designated textbook. The fifth-grade science textbook was designated based on the 2007 National Elementary Science Curriculum.

predictions in their workbooks. I planned to have the students use these workbooks again after a few days when they would then be asked to write about the results of the experiment. Then we would compare the two. However, one student, HI, came to me and said,

> HI : Teacher, look at the bottom of the workbook. There is a question asking why the amount of the water decreased. It shows the answer to the expectation question. Why did we even do it then? It's ridiculous.

This made me realize that some parts of the workbook were having some mistakes. Figure 3.3 is the mistake that HI pointed out.



뿌리의 구조와 하는 일을 알아볼까요?

교과서 98~101쪽

관찰을 통해 뿌리가 하는 일 알아보기

1. 땅 위에 있는 식물 모양을 보고, 뿌리의 모양과 뻗어 있는 정도를 예상하여 그려 봅시다.

2. 식물의 크기와 뿌리의 길이를 비교하여 어떤 관련이 있는지 결과를 써 봅시다.

생각해 볼까요?

1. 위의 각 식물을 손으로 뽑는다면 어떻게 될지 생각하여 봅시다.

2. 바람이 불 때 뿌리가 없다면 식물이 어떻게 될지 생각하여 봅시다.

50

3. 식물의 뿌리가 하는 일을 정리하여 봅시다.

양파 뿌리가 하는 일 알아보기

1. 양파의 뿌리가 없다면 양파가 어떻게 될지 예상하여 봅시다.

2. 두 비커에 양파를 2~3일 동안 놓아둔 후, 두 비커에 남은 물의 양을 비교하여 봅시다.

생각해 볼까요?

1. 비커의 물이 줄어든 까닭을 생각하여 봅시다.

2. 줄어든 물의 양이 다른 까닭을 생각하여 봅시다.

3. 이 탐구 활동을 바탕으로 식물의 뿌리가 하는 일을 정리하여 봅시다.

51

Figure 3.3 Questions about predictions and results are on the same page

In the notebook, there are ten questions to which students needed to provide an answer. The question pattern follows the scientific process, emphasizing skills such as predicting, analyzing, and generalizing. The prediction questions on page 50 are about the role that root's play in this experiment. The questions that follow focused on having students engage in analysis and drawing conclusions based on their analysis. One of the questions on page 51 asked students to consider what role the onion roots play in "reducing the amount of water in the cup". This phrasing of this question alerts students as to what results they should see at the end of the experiment (i.e., that the water level will decrease). Thus, the notebook prompts students to write their prediction on one page, but the "expected answer" is clearly visible on the next page. This really diminished the effectiveness of the "inquiry" activity for students because the answers are already provided.

After HI brought this to my attention, I decided to address the issue by having students to write their predictions in a different notebook. We called this notebook their "inquiry notebooks" and I used them as an alternative to the school notebook. The students needed time to practice with it and get used to it. They seemed to be following my instructions quite well, but it was my first attempt at using my own teaching strategy and not using the national curriculum workbook. As I mentioned in the literature review in Chapter 1, I was a beginning teacher, and did not have self-confidence about my curriculum arrangements. I was not sure whether it was acceptable to decrease use of the workbook or whether my decision was helpful to students and encouraged them to express their thoughts more easily. Since I decided what changes to make by myself, without my students' input, there was no way to check its effectiveness. So I thought I would try cogenerative dialogues and get students' opinions.

3.2.3 How about Using the 5E Learning Cycle Model?

In an effort to improve my science teaching and to support students to make better connections between the science activities we did in the lab and the lecture and bookwork we completed in class, I decided to try a new teaching strategy and to ask my students to help me evaluate the effectiveness of the strategy for improving student engagement in science class. Since I was having hard time organizing my lesson plans, I decided to try this model. I knew it was a well-developed and widely used science instructional strategy, so I thought that by using the 5E Learning Cycle, I could better prepare my science lessons.

Wilder and Suttleworth (2010) introduce a method called the 5E Learning Cycle by introducing a lesson they designed using this model to teach middle/high school students about the cell. The authors note that a dilemma science teachers face every day is the need for balancing the content demands of state and federal testing requirements with opportunities for students to engage in inquiry. They suggest that using the 5E Learning Cycle is a realistic, constructivist way to address this dilemma. They insisted that the 5E Learning Cycle leads students through a sequence of learning in which they become engaged in a topic, explore that topic, are given an explanation for their experiences, elaborate on their learning, and are evaluated. This model is commonly referred to as the BSCS 5E Instructional Model, or the 5Es, and consists of the following phases: engagement, exploration, explanation, elaboration, and evaluation. Each phase has a specific function and contributes to the teacher's coherent instruction and to the learners' formulation of a better understanding of scientific and technological knowledge, attitudes, and skills. The model (See Table 3.1) frames a sequence and organization of programs, units, and lessons. Once internalized, it also can inform the many instantaneous decisions that science teachers must make in classroom situations (Bybee et. al, 2006).

Table 3.1 Explanation of the 5E Learning Cycle Model of Instruction[13]

Phase	Summary
Engagement	The teacher or a curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

Using this model, I decided to design a lesson using a video clip of a TV show with which the students are familiar with or pictures to help 'Engage' students in the lesson. I wanted my students to pay attention to the beginning of the lesson when I introduced the science concept, so I hoped to attract and maintain their interest by using video clips or interesting pictures to introduce a new topic. I expected my students would become curious about the situation and better connect the main purpose of the lesson to the activities we were doing and to their own lives, which would support students to extend their learning when they moved to the next step, called 'Exploration'. In the following section, I describe how my students and I engaged in collaborative research about my use of this new instructional strategy to improve science teaching and learning in our class.

[13] Adapted from Bybee, R. et al., (2006). *The BSCS 5E instructional model: Origins and effectiveness*. Colorado Springs, CO: BSCS.

3.3 OVERVIEW OF RESEARCH PROCESS

3.3.1 Procedure of the Research

In this section, I describe the general methods employed in this research. Specifically, I detail the process of engagement with my students before, during, and after cogenerative dialogues (see Figure 3.4).

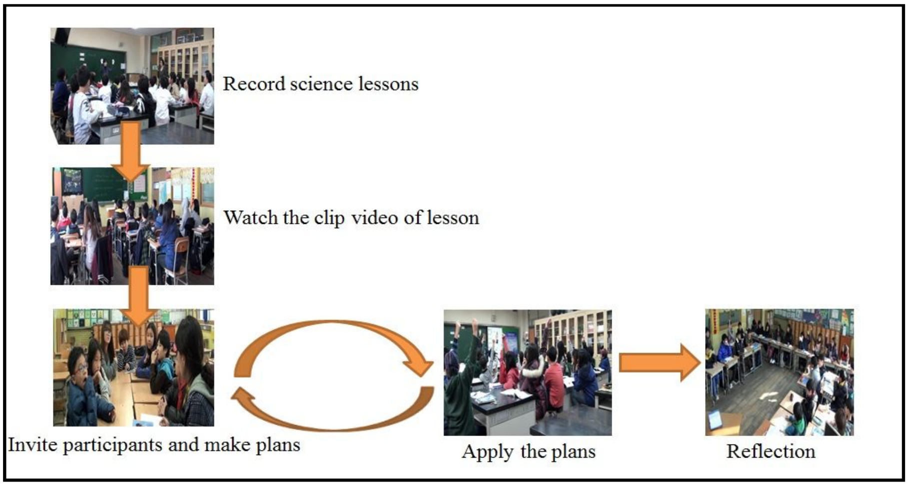


Figure 3.4 Overview of cogenerative dialogue process with my students.

In the first step of the process, I video recorded our science lesson using two stationary cameras (positioned at both the front and back of the classroom). In addition, some lessons were captured using hand-held video cameras by visiting researchers (Dr. Martin and Ms. Park). Using the hand-held cameras, these researchers walked around the room during instruction and focused the camera on different small groups to capture the dialogue and interactions happening in small group interactions. Table 3.2 shows the cogenerative dialogue that we had during the research. I described what we did during each cogenerative dialogue and put the symbols for the better understanding. I will describe the cogenerative dialogues referring to these symbols.

Table 3.2 Cogenerative Dialogues took part in the research.

Date	Type of Cogenerative Dialogue	Summary	Symbol
November 2nd 2013	Whole class cogenerative dialogue	Watch the science lesson and exchange reflection or suggestions. Students wrote the research notebook as well.	Cogen_W1
November 5th 2013	Small group cogenerative dialogue	The first group cogenerative dialogue after having Cogen_W1. Brainstorming the solutions.	Cogen_G1
November 6th 2013	Small group cogenerative dialogue	Suggest the idea for solutions	Cogen_G2
November 8th 2013	1:1 cogenerative dialogue	Talk about the attitude during the break time with DI.	Cogen_I1
November 13th 2013	Small group cogenerative dialogue	Review the result and modify the rules	Cogen_G3
November 26th 2013	1:1 cogenerative dialogue	Talk about a strategy that I could use to help DI.	Cogen_I2
December 20th 2013	Whole class cogenerative dialogue	Reflection on the research	Cogen_W2

In the second step of the process, I did the whole class cogenerative dialogue (Cogen_W1) where we watched the video from the classroom to identify any problems we saw or anything that we found interesting (*Ontological Phase*). During this meeting, all students were asked to write down their reflections and suggestions in their own research notebooks as well. Students shared their notebooks with me and I invited interested students to a follow-up small group cogenerative dialogue (Cogen_G1, Cogen_G2) to reflect on the initial problem, the cogenerated solution, and to assess our collective action. During this time, the students and I engaged in a typical cogenerative dialogue, each taking responsibility to speak about problems we identified (*Educative Phase*) and to "cogenerate" solutions for the problems.

In the third step of the process, we shared our findings and suggested solutions to the whole class and we collectively implemented the cogenerated plan of action (*Catalytic Phase*). During this step, we captured video, which we then reviewed in a follow-up, small group cogenerative dialogue (Cogen_G3). In the final step, we engaged all of the students in a whole-class cogenerative dialogue (Cogen_W2). In this phase, I engaged in one-on-one cogenerative dialogues (Cogen_I1, Cogen_I2) and whole-class cogenerative dialogue (Cogen_W2). I asked that students reflect on the actions we had taken and to evaluate the effectiveness of our implemented changes. Specifically, we addressed whether the changes were equitable and fair for my students and me (*Tactical Phase*). Finally, we made a collective decision to either "keep" the changes or to engage in a new cycle of cogenerative dialogues to cogenerate an alternative solution.

3.3.2 Getting Started - Introducing a Problem to Solve Together

In this section, I describe how I first engaged my students in the research project and I describe first step of the cogenerative dialogue process. My analysis of the data focuses on making sense of how the *Ontological Phase* of cogenerative dialogue impacted my GPK and I argue that my growth in this area positively impacted my PCK regarding science teaching in the elementary level. Below is a screenshot (see Figure 3.5) captured from video taken while I was introducing the research project to my whole class. I was inviting my students to participate in research to improve science class. I am holding the research notebook to show the process of our research and saying the words follow:

CM: Last semester, I did research on improving my teaching and I realized that your thoughts and opinions are the most important in improving our class. We—you and I—need to work together. So I suggest doing research together to improve our science teaching and learning. I am convinced that we can make positive changes through this research. We are now a research group and I really hope you would happily and actively enjoy the research.

So I asked them to participate as co-researchers.

Figure 3.5 Me standing in front of students

Following this introduction, I told students about my decision "try out" a new instructional strategy called the 5E Learning Cycle and that I wanted them to help me determine if the strategy was effective for their science learning. I asked them if they would be willing to give me some feedback about my suggestion to use this new instructional strategy, especially the first step "Engagement". The students all agreed they would give me feedback about my use of this new strategy.

So starting the next day, I implemented my first 5E lesson. At the end of the lesson, I asked students to review video from the first 8 minutes of the lesson, which consisted of the "Engage" part of the lesson (See figure 3.6).

Figure 3.6 Watching the video of "Engagement" step (Cogen_W1)

After viewing the video, I asked that students give me general feedback about the use of this teaching strategy and asked that all students write a reflection about the class in their notebooks. The students were instructed to keep track of their reflections on the lessons by writing the title of the lesson at the top of the in their notebook and to then describe, in their own words, the content of the lesson, and to reflect on what I did in to "engage" them in the first step of the model. Initially most students provided simple comments about the strategy that I used in the lesson, writing that the lesson was 'Good', or 'Not bad'. As we kept discussing the video, they began to analyze my strategy more critically and they gave me more detailed feedback and suggestions about things I could do differently.

I did this because I wanted to know what they thought about my teaching strategy and its affect on their science learning. Before receiving their feedback, I thought that if something were interesting to me, then it would also be interesting to my students. But as I prepared to do the participatory research, I began to wonder if this were really true. Because I realized that I had never asked my students their opinion, I asked every student to write an entry into their own research notebook. My students took this opportunity very seriously and every student wrote their opinion. Next I collected the notebooks I read all of students' reflections. Next I divided their thoughts into several categories and organized them into a chart (Table 3.3) based on Abell's (2007) revised PCK model (see Figure 1.1).

Table 3.3 Problems students identified about science class

PCK component	Content	Number of student answers (% of student answers)
General Pedagogical Knowledge	Classroom management	12 (48%)
	Instructional principles	8 (32%)
	Learners and learning	3 (12%)
	Other	2 (8%)

Mostly students were thinking similarly to me. They were pointing out that students were too noisy and standing or walking around unless teacher scolded them. I was impressed that they noticed these things as limiting our ability to successfully engage in our lab. In addition, I was also impressed to find that they were thinking about my use of this new strategy. For example, they asked me to give more chances and time to do the activities on their own before "telling them the answer". In addition, students suggested their idea about how to more effectively distribute materials at the beginning of the experiment. Based on their recommendations, I decided to do follow-up cogenerative dialogues with small group of students to cogenerate the solutions more effectively.

3.4 THE ONTOLOGICAL PHASE – SHARING INDIVIDUAL PERSPECTIVES

After analyzing the student research notebooks, I learned that the majority of the students noted a deficiency in my GPK was preventing them from learning during science class. Namely, the issue was my inability to effectively manage student behaviors during an interactive science lesson because students became too excited and too loud.

This learning environment problem is a common problem for beginning teachers and this problem manifested itself most when I attempted to teach science lessons using inquiry. I wanted to engage students in conversation about their prior learning experience, however students became too unruly when trying to share about their own experiences and questions. Because I wanted to continue trying to use inquiry and wanted to engage students in dialogue to assess their pre-conceptions, I asked for volunteers to attend a small group cogenerative dialogue (Cogen_G1) to try to address how we could more effectively conduct the 'Engage" part of the lesson. In Figure 3.7, we are all sitting and talking about the problems that we had identified. We are listening to one another speak and share our perspectives.

Figure 3.7 Small group cogenerative dialogue (Cogen_G1)

The Cogen_G1 was done after grasping the students' thoughts about their problems in science class. The main problem that students pointed out was making noise during the lesson. For the Cogen_G1, seven students volunteered to participate. To help them to be clear about the purpose and the process of the cogenerative dialogue, I made an announcement before we started the cogenerative dialogue. In the following transcript from a group cogenerative dialogue with students, I explained the purpose of the group cogenerative dialogue.

> CM: Now, what we are going to do from now on is …. We had some lessons right? And we recorded them. You can talk freely about your thoughts—we have to fix this [issue of noise] in our science class. For example, [you can say] "Teacher, I don't think this is good. Let's change this." Like this. You can talk about your thoughts freely . . . you might think, "Can I talk about this?" [Yes]. Because sometimes a student might write about very minor things, [but] that maybe something the teacher hasn't thought about yet.

In this introduction, I attempted to explain to students that I wanted them to share their thoughts freely. However, as it was my first cogenerative dialogue and their first time to speak freely with a teacher to give feedback about a class, it was difficult to encourage them to speak up at the beginning of the cogenerative dialogue. It was their first time to talk in a group about our own problems, so they were excited. At first, they were more comfortable speaking to one another. During first 10 minutes they gave many suggestions for decreasing student noise that were creative, but unrealistic. For example, they suggested two-hour time outs for students who are not following teacher's instructions.

The first time we met, we were only able to speak for about 15 minutes because we met during a break. We decided we needed to conduct a second cogenerative dialogue (Cogen_G2) to continue the conversation. Students left the meeting agreeing to continue to think about our problem and to return to the next meeting with more suggestions. When we met for Cogen_G2, the students were more focused than before and we were able to begin a real conversation about the problems in our class. For the Cogen_G2, within the first 3 minutes of talk, students were offering useful suggestions for the noise problem and even raising other issues to discuss. The following transcription is taken from our dialogue in which the students talk about the problems and make suggestions during Cogen_G1 and Cogen_G2.

> EK: When the teacher scolds a student, the other students have to wait until teacher stops and time goes on.
> CM: Oh, this must be an important point. When I point out to students and warn them about the bad behavior, I wasn't thinking about the other students waiting for me to finish. Do you have any good idea to solve this problem?
> EK: How about using sticker system in our science class? Give the students who show the bad attitude stickers like a yellow card [warning system used in sports like soccer] instead of talking such a long time. And when they get three stickers, they have to do the extra work for our class.
> DI: Dancing in front of the class?
> HS: No, then we will keep laughing and we would waste our learning time.

Engaging the same students in Cogen_G1 and Cogen_G2 was an effective way to encourage student involvement and to demonstrate to them that I really wanted them to have ownership over the direction of our research. Different types of learners had equal chance to speak and they shared their opinions and were respected equally. As we continued with our cogenerative dialogue, the students began to realize this was not just a "chat" but also an essential practice in our research and so they started to talk about problems and suggest their own ideas very actively. Through this process we were able to suggest ways that individual students could share the responsibility of improving our science class.

There were boys and girls, high achievers and low achievers. The diversity of the group cogenerative dialogue provided us opportunities to listen to different perspectives. I had a chance as a teacher to share my perspective and different types of students had a chance to share their perspective. In doing so, participants "verbalized" the way they see the classroom, teaching and learning, and science. It was not easy at first, so we needed multiple chances for students to feel comfortable and confident. But engaging in the practice multiple times, it helped students to see that I valued what they had to share.

In this way, we became *educated* about other people's perspectives. In the section that follows, I discuss analysis from a whole class cogenerative dialogue to better explain the *educative* phase of the process.

3.5 THE EDUCATIVE PHASE – LISTENING AND LEARNING FROM OTHERS

In the previous sections, I explained how cogenerative dialogue provided us the opportunity to talk about our own perspectives to one another regarding my teaching practices. However, cogenerative dialogue is also useful for teachers and students not only talk to one another, but to also hear one another.

This section focuses on learning to listen to others and to be educated by their perspectives. I have been a student before, but I was a 5^{th} grader a long time ago and the issues I faced as a 5^{th} grader 20 years ago are different than what problems my students face today. In this section, I will introduce whole class cogenerative dialogue (Cogen_W2) as a valuable social space for Educative Phase to occur (see Figure 3.8).

Figure 3.8 Whole-class cogenerative dialogue (Cogen_W2)

During Cogen_W2, we reviewed our research and exchanged our thoughts about our research. Similar to what happened in Cogen_W1, we used research notebooks to make students feel more comfortable expressing their thoughts. However, students were expressing their thoughts very actively than Cogen_W1. They were no longer acting as simply participants, they were now engaging as co-researchers in our research. The following are excerpts from Cogen_W2 or students' research notebook.

> SM: I feel our science class changed in very good way because teacher listened to us and accepted our suggestions. And we also tried hard. The research notebook was really good for sending my thoughts to others.
> EK: I was happy that my opinion was accepted and applied in our science lesson. I also felt responsibility of my science class.
> (Talk during Cogen_W2, December 2012)

> "We could see teacher was trying to do better science class and have passion to help us and this was the experience I had not seen before. She accepted our opinion and made our science class better than before."
> (JH, Reflection of research, December 2012)

> "I am happy to have chance to help my teacher in the research. I used to hate science but this year, teacher and my classmates helped me to improve my science. I appreciate that."
> (IJ, Reflection of research, December 2012)

These are the examples show that we could be educative by means of cogenerative dialogue. We had several chanced to talk and exchange our thoughts. Moreover, we also tried to respect each other's opinion and apply our ideas to the next science class. We built trust by listening to one another. As a result, we talked about the challenges or suggestions more easily and actively.

In any classroom, no two students who are same – but they are generally all treated as though they have no differences. In addition to teachers not seeing students as different from one another, students also have not generally considered what it is like for other students in their classroom. Schools don't provide many opportunities for students to talk about or analyze their experiences as learners. Cogenerative dialogue offers students an opportunity to do this. In addition, children are rarely engaged in true dialogue with adults about anything in schools. This opportunity provided students a chance to learn more about how teacher experienced the classroom, what I needed to think about and did as the "teacher" and I as a teacher had a chance to learn from students.

As my students began to share their opinions more actively, I also began to learn about who my students were – how they learn, what strategies they felt was most effective, how they felt I should improve my classroom management, etc. These dialogues and what I learned from them led me to expand my GPK. We reviewed our research and evaluated our changes. I could see dramatic changes in engaging in our conversation. The students who participated in the group cogenerative dialogues had a chance to talk about their feelings to their classmates, some of who had not participated in the small group cogenerative dialogues. The students who did not do the group cogenerative dialogues did not hesitate to talk about the efforts their friends made to improve our science class and also suggested ideas for the next research. Students were becoming more comfortable with the idea of the research as their trust grew because they believed I would listen to them.

This process provided a great chance for us to think about our project, exchange reflections, and realize that we are starting to understand one another. We were able to learn that every member in the classroom was able to contribute to the improvement of the class based on trust.

3.6 BUILDING RELATIONSHIPS HELPS TEACHERS BUILD GPK

"When I did the lessons I thought I'm in control or should control students. However, during this research, I have grown to realize that students could help me and help their peers to improve science teaching and learning. I am not isolated. I have my students who can help me."

(Changmi research notebook, November 2013)

These words are the notes that I wrote in my research notebook just before we conducted our final whole-class cogenerative dialogue. When I first began this research, I knew I needed to transform my teaching practices, but I did not know I could get any help from the students. I was struggling to figure out problems and solve them by myself. However, now I know if I trust my students and ask for help with an open mind, they will happily help me to improve our classroom, including changing their own behavior. Learning how to share responsibility for student behavior, rather than being solely responsible for "controlling" student behavior is one of the most important things I have learned from my research. This recognition demonstrates an important way my GPK has grown as a result of my interactions with my students. Because I have a better understanding of my students as individuals and because I have learned to build relationships with my students, I have also gained insights into how to better manage the learning environment to be more productive for my students.

In the previous sections, I described the first two phases of cogenerative dialogues (*Ontological and Educative*). In this section, I share evidence of the ways in which these two phases supported a transformation of my teaching practices as a result of my ontological shift I held about the ways in which teachers and students should interact with one another in the classroom. Specifically, in this section, I share examples from my data that demonstrate the ways in which my interactions with my students expanded my understanding of who they were as learners, which provided me with a wider range of possibilities for how I chose to engage with these students. I assert that my developing GPK of my students as learners and as individuals helped me to transform my science teaching because I was able to enact new practices that benefited my students. After introducing these two vignettes, I return to the discussion about how what I learned from my interactions with these students helped improve my science teaching.

3.6.1 Building a Positive Relationship through a Short Conversation

Prior to our meeting in cogenerative dialogues, my practice was generally to publicly chastise students for bad behavior. This was not always a very effective method as it sometimes made students more upset or made them disengage from the class and from learning. One student, DI, was particularly difficult for me to manage. He was always filled with energy and talked a lot during class. Sometimes it disturbed our class and I scolded him for it. However, when I publicly embarrassed him, he would withdraw from class. This was detrimental to his learning and it also disrupted his small group activities because he would not participate. In this example, I share a screen shot of what happened after I scolded DI about not concentrating on the lesson and talking with his group members.

Right after I yelled at him, his attitude changed suddenly and he stopped engaging in the lesson.

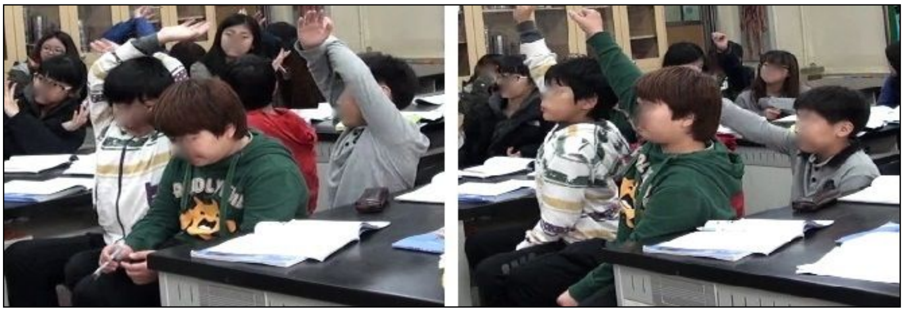
Because I had been engaging in small group cogenerative dialogues with DI, I had developed a relationship with him and I felt badly that he was not participating. I valued his contributions to his group and wanted him to re-engage in the lesson. So I decided to have an impromptu one-on-one cogenerative dialogue with him about what had happened and to cogenerate some plan for moving forward in a more positive way. The following screenshot (Figure 3.9) was captured during our discussion.

Figure 3.9 One-on-one informal cogenerative dialogue at break time (Cogen_I1)

During our discussion, I asked DI to tell me what was happening and to let him know I was disappointed by his disruption of my lecture by talking. DI responded,

> DI: Actually, it wasn't what you thought. I wasn't chatting with the group members. Hun was not doing any writing at all so I told him to do something. And I was trying to help him but he wasn't listening at me. So I kept trying to do some writing.

DI's transformation after our dialogue was immediately noticeable when we began the second half of our double period of science. The screenshots (See Figures 3.10a and 3.10b) of DI before and after our conversation are evidence of the positive affect our conversation had on him.



(a) (b)

Figure 3.10 The change that DI showed (a) Before cogenerative dialogue (b) After cogenerative dialogue

If I had not stopped to speak with him in the one-on-one cogenerative dialogue, I would have continued to believe this student was disruptive and disrespectful. After hearing his explanation, I apologized immediately about my misunderstanding and promised him to figure out a way to help Hun to engage with the class and with other students and not make DI concerned anymore. I also asked him if he had any other problems with his team and suggested they try to solve them together or with me. I emphasized that just as we had solved our problem together, his team could also solve their problem together.

3.6.2 A Deeper Understanding of Students Means Better Opportunities to Teach

In this vignette, I describe a second student, DH, who had considerable difficulties in engaging in science class. DH was one of my biggest concerns during the whole school year. He was from a multi-cultural family and had many challenges in learning. He could not write Korean well and because of that he had many difficulties in all subjects. Although he participated very actively in science class activities, when it was time to write about his experiences in his science notebook, he did nothing but stare at his friend's notebook. I wanted to find a solution to his problems based on his feedback, so I decided to engage him in a series of one-on-one cogenerative dialogues. From these conversations, I was able to gain deeper knowledge about this student's situation and, as a result, I was able to develop more effective strategies to support him as a learner.

During my first action research project, I had introduced to DH some individually designed worksheets that I felt would provide him more structure to complete the work. I made his worksheets different from the other students' in order to help him engage in the class. Some of the differences in his worksheet were that it had fewer problems, easier vocabulary, and contained more visuals, diagrams, etc. When I first gave Hun the worksheet, he did not say anything about them, but for the first time, he completed his work. It seemed that he was not isolated anymore and was engaging in the class with other students. I thought it was helpful, so I decided to engage DH in a cogenerative dialogue to ask him what other kinds of changes he could suggest for me to help improve his science worksheets. Below is an excerpt from our conversation.

> CM: I see you enjoying the science class.
>
> DH: Yes, it's fun.
>
> CM: But I don't see you filling in the blanks in the workbook or writing down your thoughts in your inquiry notebook. Can you tell me why?
>
> DH: [silence].
>
> CM: Learning science is as important as enjoying science. Since you're enjoying the experiments very much, I think you are already ready to learn science. I would like to help you with writing. Is it hard for you?
>
> DH: Yes, a little bit.
>
> CM: Then, do you remember the worksheets that I provided you last semester? [The worksheet] had easier words [on it, but] with similar meanings. Shall I make another one for you?
>
> DH: [silence].
>
> CM: You can say whatever you want. It will be much easier for me to help you if you say your feelings honestly.
>
> DH: I want to do the same thing as others.

CM: Oh, I didn't know that. Thanks for telling me. Then what is your biggest need when you do the same work with your friends?

DH: Words [vocabulary].

CM: Okay, then I'll help you to more easily understand the words you're having problems with. Will that be better for you?

DH: Yes.

(Conversation with DH during Cogen_I2, November 2012)

That was the first time I had heard DH's thoughts about my efforts — and I was really hurt to hear that my extra work did not make him feel good. It was too difficult for me to hear what he was saying because it would mean that the time and effort I had spent making the worksheets for him was wasted. It was only then that I remembered some of the students had seen the special worksheet that I given to him and they complained that they also wanted an "easier worksheet" to do. When I reflected on this later, I recognized that this situation could have made him embarrassed. I was really sorry that I had heard what these other students had said, but I had not listened and I had not considered how their comments affected Hun.

I finally realized a simple but important thing is that what is best for me, may not be best for others. I should have asked him what he needed and I should have listened to his thoughts before I even tried to help him. Through these individual cogenerative dialogues, I was able to build stronger relationships with students and convince them that I am trying to help them.

3.6.3 Expanding Students' Knowledge about Teaching and Learning is Important Too

One of the most meaningful things I took away from this research was that engaging students in cogenerative dialogues not only helped me to understand my students better, but it also allowed students to better understand me. At the beginning of the project, I had asked students to complete a brief questionnaire asking them to describe what they felt was a “good” teacher. Many students indicated that a good teacher is a person who *gives* something good and valuable to students and they also answered that students should *listen* to the teacher and *follow* instructions. These answers revealed that my students held a stereotype about the relationship between teachers and students that is very one-sided, with teachers being in control and being the only one able to offer something valuable. I imagine many students struggled with this stereotype while they were doing the first cogenerative dialogue and were being put in the position of “giving” something valuable to me and of having a teacher in the position of “listening to students”. Only after my students learned to trust me and to understand that I really intended to engage them in real conversations did they start to talk sincerely.

At the end of the research project, I asked students to write an entry about their final reflections on the process and to discuss how they felt about what we had done together and what we could continue to improve in the future. Figure 3.11 shows the research notebook of one of my students reflecting on our research.

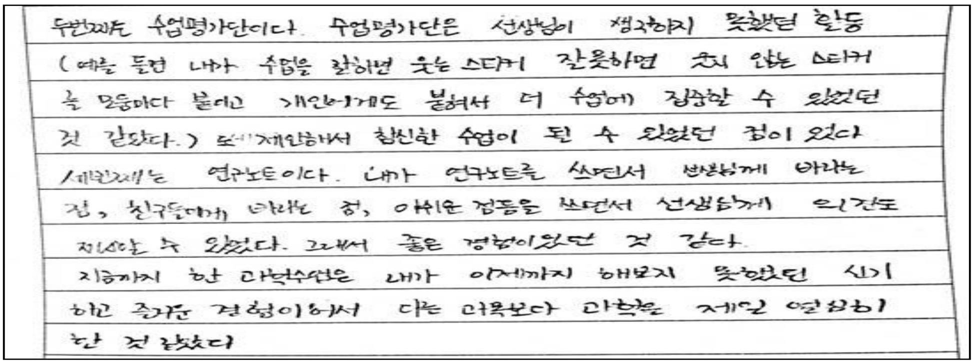

두번째는 수업평가단이다. 수업평가단은 선생님이 생각하지 못했던 활동
(예를 들면 내가 수업을 잘하면 웃는 스티커 잘못하면 웃지 않는 스티커
를 모둠마다 붙이고 개인에게도 붙여서 더 수업에 집중할 수 있었던
것 같았다.) 또 제안해서 참신한 수업이 될 수 있었던 점이 있다
세번째는 연구노트이다. 내가 연구노트를 쓰면서 선생님께 바라는
점, 친구들에게 바라는 점, 아쉬운 점들을 쓰면서 선생님께 의견도
제시할 수 있었다. 그래서 좋은 경험이었던 것 같다.
지금까지 한 과학수업은 내가 이제까지 해보지 못했던 신기
하고 즐거운 경험이어서 다른 과목보다 과학을 제일 열심히
한 것 같았다

Figure 3.11 A student’s research notebook

In this notebook entry, this student said that the science class this semester was really different from other subjects and from other science classes that she had before. She said she really enjoyed this science class because she experienced many different things that she had never done before. One was cogenerative dialogue. She wrote that as a result of her group's cogenerative dialogues, they were able to suggest a great idea that the teacher had not thought of before and that their idea had helped to change classroom practices. She pointed out at another difference in this class was that she was asked to keep a research notebook. In this notebook she felt she could write her own reflections about each class and she enjoyed that this process gave her an opportunity to share her thoughts to her teacher. Many other students wrote that this research was valuable in that it gave them a chance to understand a teacher's perspective, to show their feelings, and to contribute to something to our science lessons. Through this process my students and I shared the responsibility for improve our science class and we tried to cooperate for progress. Since they suggested some ideas to try, when I implemented them, they tried to abide by the rules they made. And they realized that they could commit to something to improve our science teaching and learning. They understood the purpose of the research, so they could give me the feedback I needed to improve my science teaching strategies. Many of the students wrote in their notebooks that our science class was the most valuable science class that they had ever had. Some students who had even hated science before now showed improved attitudes towards science and they were participating more in activities. Thus, we were really able to begin transforming our classroom by speaking to one another and being heard.

3.7 CONCLUSION

In this chapter, I tried to show the problems existed in my science class and the flow of the research. And also I described the evidence of ontological shift in the teacher and students' perspectives with some evidences. Prior to engaging in cogenerative dialogues with students, both in small groups and the whole class, I had very few opportunities to really "talk" with my students. Before beginning my research, I was relatively "stand-offish" from my students and spent little time speaking with them one-on-one. As a result, I did not have many strong relationships with students. My limited interactions also meant that I had limited knowledge about how to effectively interact with my students. This was especially problematic for me with a few male students who often disrupted my class with inappropriate behavior.

As a result of decreased disruptions and increased teacher/student harmony in the classroom, I was able to devote more time and attention toward new science teaching strategies, which provided students with more opportunities to engage in science laboratories, inquiry activities, and collaborative work. In doing so, I had more opportunities to actually "teach science" meaning I had more chances to "practice" the strategies I wanted to implement. New teachers need time to try new strategies, to fail, revise their attempts, and try again. It is in these attempts that teachers can develop their PCK related to science teaching. In the following chapter, I will explain the changes that we made and limits that we faced as examples of the *catalytic* and *tactical* phases of this research authenticity.

CHAPTER 4

MAKE THE CHANGES

"It was the first time in my school life that we were able make the changes ourselves. I realized that we could improve our science class together. I was happy to have a chance to help my teacher. And it was really exciting!"

(JY, Student's reflection, December 2012)

The words above are from a student's reflection written in her research notebook. She wrote that it was exciting knowing that she could change something. Not only her, but also many other students mentioned they were happy they could contribute to positively transforming our science lessons. When we did the Cogen_W2, I found that many students felt agreed with this student's assertion that our science class had changed for the better.

As I described in previous chapter, in sharing our individual experiences, cogenerative dialogues provided us with an opportunity to enrich our understanding. I also wanted to look at how what we learned from participating in this research could improve science teaching and learning. So I specifically looked for examples of the ways in which our use of cogenerative dialogue aligned with the *catalytic* authenticity criteria that support teachers and students to collectively co-generate solutions for problems. In this chapter, I describe some of the changes my students and I made and I evaluate the effectiveness of those changes relative to the science teaching and learning in our classroom.

Finally, I consider some of the limitations of this process by focusing on the ways in which our research aligned with the *tactical* authenticity criteria. Specifically, I address limitations teachers and students face when problems exist that are beyond their ability to "fix" in the context of the classroom.

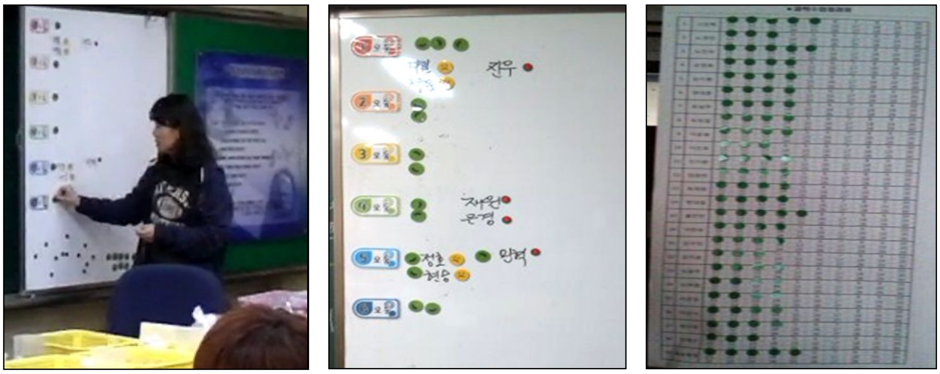
4.1 CREATIVE A NEW SOLUTION

4.1.1 Exchanging Ideas and Setting the New Rules

In this section, I share some excerpts as evidence of how the *Catalytic* phase occurs as a cycle that requires participants to come together to identify problems, cogenerate solutions, implement the solutions, and then continue meet to review how the implemented are working and to decide if additional changes need to be considered.

During Cogen_G1 and Cogen_G2, we talked about some problems such as unruly behaviors and noise and we exchanged ideas about how to solve those problems. As a result, we developed new rules for how to manage student's behaviors during science class. After my students and I engaged in the small group cogenerative dialogue to design this method, I announced the result of Cogen_G1 and Cogen_G2 and the new rules to the whole class. In this way, I introduced the recommendations of a small group of individuals to the whole class and I asked for all students to consider the suggestion and to decide as a group if we would implement this change. When I was describing the process, if I missed an important point or had difficulty explaining the process, students who had attended the small group cogenerative dialogues helped to clarify by re-stating the rules or giving examples from our previous discussion.

The rules were designed based on a reward system using stickers (See figure 4.1). Since, there were many small group activities engaging students in collaborative work, we decided that the reward cards (Green smiley faces) should be awarded to the whole group – so groups would share in awards. However, warning cards (red frowning faces) were awarded to individuals based on their actions. Each time a student misbehaved, I would place a red frowning face next to their name. If a student misbehaved a third time, then they would get a demerit card (a yellow sullen face). If any student in a group received a yellow card during the lesson, their group would lose a green sticker. In this way, individuals were warned about their behavior, and if they continued to misbehave, their individual actions could harm their group.



(a) (b) (c)

Figure 4.1 Class rules: (a) Me putting reward card on board (b) reward and warning cards on the sub-board (c) green reward stickers next to students' names on chart.

After each class, the students added up the number of reward cards gained by their group and they placed green stickers next to their names on a chart that was hanging on the wall. Students could exchange green stickers for some small gifts like stickers, erasers, and pencils. So students had an incentive to improve their behavior and increase the number of green stickers they received. Students could receive green smiley face cards by raising their hands to answer questions, paying attention, actively working with their peers, and generally being "on task" during science class.

The purpose of the rules was for individual students to receive reminders to help students who struggled to behave during whole class discussions [especially during Engage and Explore parts of 5E lessons] to modify their own behavior so everyone in class could enjoy the science activities without too much noise and chaos. By focusing attention on individuals, we attempted to put responsibility on the individual for changing their behavior – but by also connecting it to their group reward system, we tried to place some emphasis on the need for members of groups to also be responsible for their peers' behaviors. In addition, when groups worked well together to complete lab activities and engage in small group discussions, they would be rewarded for their actions.

We used the new rule system for several classes and then we had a second group cogenerative dialogue to evaluate how the change had affected individual students' behavior and whether that change was improving our ability to engage in science lab activities without too much noise and chaos. The following transcript is an excerpt from our cogenerative dialogue where we discussed these changes.

CM: We have had several classes after our first and second cogenerative dialogue (Gogen_G1, Gogen_G2). During that time, we applied our new rule in the class. How was it? Please share your thoughts.

JW: I think the sticker system worked. Students are quieter than before.

MH: Yes, the stickers. They were good because students think about the presents [rewards] they can get with stickers.

WB: But sometimes the sticker system made us noisier.

CM: Really? Why do you think like that?

WB: When you put the green card, students try harder to raise their hands. But when we get the yellow card, we blame each other and sometimes argue about that.

JW: Yes, sometimes it feels like the sticker system doesn't work.

CM: For me, it was much easier to teach actually. However, I was quite busy teaching and putting stickers on the board at the same time. And also when I put up the yellow sticker, I could see your face becoming angry. And I'm a little bit worrying about my limits [to apply this fairly] because I can't see all of you at the same time and check your behavior. Okay, so I guess we think the sticker system works in some ways but doesn't in other ways. Let's think about this system more.

(Conversation during Cogen_G3, November 2012)

Many students in Cogen_G3 agreed that when students received a yellow card, it made the students in their group lose concentration on the lesson and that it was embarrassing in front of the whole class. In addition, I shared that I did not feel confident that I could see everything accurately, so I worried I sometimes made mistakes when giving cards. To try to address these issues, we made an adjustment to the rules by adding a "back-up system" whereby the teacher would share responsibility for assigning warnings with group leaders. Each group leader evaluated the behavior of their group members during class. They were able to warn their group members two times. If the member did not stop after having two warnings they wrote down that student's name and gave it to me. That student would then receive a yellow card for that lesson. Before students turned in the list, they were asked to engage in a member checking activity (see Figure 4.2) with all members to determine if everyone agreed on their recommendation to the teacher.

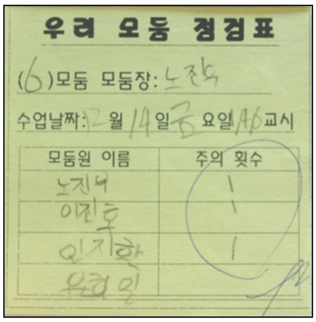


Figure 4.2 Small group behavior member checking sheet

During Cogen_G3, some students worried about the behavior of group leaders and whether students could be fair in this duty. To address this potential, the group decided to implement a "double checking system" where group leaders would check the behaviors of members using the small group check sheet (See Figure 4.2) and I would also take some notes in my research notebook during the science class to cross-check the identity of students who did not engage in the science class and who made noise. This allowed me to compare my notes with the group leaders. After determining who had received yellow cards, I would speak individually with those students about their behavior rather than scolding the student in front of the whole class.

In this way, group members took on the role of warning their peers to modify their behavior so as to cut down on the amount of whole class instructional time where I would be “yelling” at students. We wanted to reduce the amount of time that was “wasted” on verbally warning students. After each class, I asked each group member to come out into the hallway with me to review their small group member check sheet, which we would compare with my notes. After double-checking each student’s name, I would make the final decision as to who would get a yellow sticker for that science class.

By engaging in a cycle of cogenerative dialogues, we came back together to reflect on how effectively we were implementing the new class rules and we worked to modify the rules to be more suitable for our class situation based on feedback from students, as well as my own input. The results of this rule change were that our class had more time to engage in small and whole class conversations because I was not using so much class time to punish individual students. This meant I had more time to work with small groups, to engage students in lecture and activities, and to focus more of my attention on teaching rather than on managing student behaviors.

4.1.2 Re-structuring Laboratory Activities Let Us Save Time for More Science!

In this section, I offer a second example of how my students and I re-structured our classroom to improve the learning environment, which ultimately improved our teaching and learning of science. In our small group cogenerative dialogue, my students and I also talked about how I currently structured the way that students accessed the laboratory experiment materials for each group at the beginning of an activity. Several students noted that the current method was a little chaotic. Another student, SM, mentioned that it would help them to understand the experiment better if they had a chance to look at the materials for I explained the experiment. SM wrote in her research notebook,

> "When the teacher gives us the materials, some of the students are standing up and talking each other. I think it would be better and the students would be quieter if the materials were ready before class."
>
> (SM's research notebook, November 2013)

After reading her research notebook, I watched several videos from the beginning of our science class to analyze what happens at the start of labs. Again, I found that what my student noticed was true. From the video, I looked really flustered handing out the materials and I could not manage the students (or even myself). Students were standing up and moving everywhere. Some students were asking me about the materials and the lab, but I could not even hear them. Figure 4.3 (a) is a screenshot of the moment I give the materials to students. My usual strategy for handing out class materials was assign a number to each group member from 1 to 4 (most groups consisted of 4 members) and then to call for one number (example – all students assigned the number 3) to come to the front to receive the materials.

While I was giving students the materials, I was so busy that I had no chance to look how my class was becoming so chaotic. Figure 4.3 (b) shows that almost every student in class is out of their seat and standing around while I am handing out the materials. The situation was not only very noisy, but it could have been very dangerous as students could have tripped and broken the glass or spilled the chemicals on someone.

(a)

(b)

Figure 4.3 Commencement of lab: (a) Teacher hands out materials (b) Class is chaotic

In Cogen_G1, I brought up this problem and announced and asked for student input. Following a brief discussion, I suggested that in the next lab meeting, I would prepare the materials before class for each group and then have one student from each group come up to receive their materials while all other students were seated. We decided to try this out and then re-convene in another cogenerative dialogue to have students evaluate this change. The following transcript is from our discussion about the changes in Cogen_G3.

> HS: When you had to go to the front and get the materials yourself, it was really disorganized. The students from the group farthest from the teacher's desk had to go very far before. But now, we don't have to do that . . . so . . . so . . .
>
> JY: It's very convenient.
>
> HS: Yes, it's very convenient.
>
> WB: By the way, could you help make it easier for us to distinguish, for example, sugar and salt. Putting on labels or something like that.

CM: Oh, sure. I will do that next time.

JW: Last time, we brought the materials with us from teacher's desk to our desk. But now, since all materials are in the basket all together, it's much more . . . more . . .

CM: Safe

JW: Yes, safe.

(Conversation during Cogen_G3, November 2012)

Students realized the positive changes resulting from our cogenerative dialogues and they agreed that our research was actually helping us to improve our science class. In the sections that follow, I discuss how some of the changes that were catalyzed as a result of our collaborative research helped me to expand my PCK related to teaching science and my GPK related to improving general classroom interactions.

4.2 CHANGES IN SCIENCE CLASS

By our continued effort, we could see the changes in our class. The changes helped us in many ways - related to saving time, involving students, and strengthen my teaching strategy. Saving time means more doing of science and also less chaotic at beginning so students were more settled and so was I. Involving students meant giving extra help for students to engage in the science class and building relationships with my students. Strengthening my teaching strategy meant that I was feeling more comfortable and was willing to try new things. In this section, I am going to present how our new solutions changed our science class and my GPK and how it influenced my PCK of science teaching.

4.2.1 Preserve Time to Do More Activities

Elementary school provides more time and opportunity to help students develop a scientific attitude and a scientific mind than in secondary schools. But in order for this to happen, science lessons have to be taught in a way that helps students to experience science and develop a scientific attitude, not just giving them science knowledge (Hong, 2008). So it is important to provide more time for students to engage in science class and do many activities. The new changes for our science class were very effective in terms of providing us more time for doing inquiry. Figure 4.4 is the scene of the science class using sticker system and preparing materials before the class.

Figure 4.4 The science class after cogenerative dialogue and setting new rules

When we started using the new system, there was a big decrease in teacher talking time. Speaking less meant that more time was spent on teaching science. As evidence of this, I measured the time I had previously wasted of our class time. I analyzed my quantity of talk and the content of my talk from the time I started handing out the materials until the time the students started the experiment. Before the new rules, this time routinely lasted 6-8 minutes of a 40-minute class period. This means my students lost almost 15-20% of their time for conducting the science experiment to my talk at the beginning of class. However, after making changes to how I distributed the laboratory materials, my pre-class talk lasted only 2 seconds. And students were calm while I was introducing the materials for the experiments as shown in figure 4.5. In addition, all students could see all of the materials at the same time. This meant that all students were able to listen to my directions while examining the materials and thinking about the process of the experiment. Before these changes, some students had not even seen the materials before the directions had been given. Not all students are familiar with the lab equipment, so this meant that some students were at a disadvantage from the beginning of the lab.

Figure 4.5 Material box in each group

After we started to use the new rules for class management, my utterances, which were unrelated to the contents of the lesson, were reduced from about 60 to 30 sentences. After the Cogen_G2, utterances were reduced to about 17 sentences. These 17 sentences took up only 119 seconds of a 40-minute science class. This meant that less of class was being spent “talking” about non-science related content. As a result of our changes, I was able to focus more on teaching science than on managing the classroom and students were able to use more time for their inquiry investigations.

At first, I was worried about the reward system of using stickers, since students might pay more attention to the stickers than the lessons. But I decided to respect my students' decision and applied it in the next science class. As I expected, there were still some problems. The impressive thing was that the students who attended the group cogenerative dialogue thought carefully about it and tried hard to make it work. They brainstormed the idea, came to a conclusion, and modified the rules. They decided to use a double-checking system of the teacher and the team leader. I wondered about having the leader be a part of the system, but the leaders who took more responsibility in checking their teammates showed a better attitude and helped their teammates to engage better in the science class (See figure 4.6).

Figure 4.6 A team leader encourages her teammate to do the writing

These changes helped me concentrate on teaching science and helped students to spend their time more in experiencing science as well. Because I saved time from changing my instructional practices, I spent less time and energy worrying about my classroom management problems and was able to concentrate more attention on actually teaching my science lesson. This meant I could provide extra activities, ask students more scientific questions during class, and meet with students individually to help move them along in the activities. My overall talk was reduced and the time saved was used for engaging students in talk. The opportunities to engage in science talk with my students and to meet with students one-on-one also expanded my opportunities to improve my not only my general pedagogical knowledge (GPK) about my students, but to also develop my pedagogical content knowledge (PCK) of students as science learners. Because I had more chances to engage in science discourse with them, I gained more insights into how my students understood the concepts we were discussing.

4.2.2 Strengthening Teaching Strategies: Inquiry Notebook, 5E Learning Model

During the Cogen_W1, Cogen_G1, and Cogen_G2, my students and I talked about the strategies I used in science class, such as inquiry notebooks and 5E. An excerpt of the transcription of this discussion about inquiry notebooks follows:

> CM: Inquiry notebooks. What do you think of the inquiry notebook we used in science class?
> JY: Isn't it almost same as the workbook?
> MH: Well, you can recognize what we did in the science class at once when you look at the inquiry notebook because it shows overall flow.
> JW: In the workbook, we mostly only write down the results of experiments.
> SM: In the inquiry notebook, we wrote what we learned with teacher, too. And we wrap up what we did during the class.
> MH: We only write down the answers to the questions in the workbook. But we write details and the process of our lesson in the inquiry notebook.
> (Conversation during Cogen_G2, November 2012)

In this conversation, students understood the purpose of the inquiry notebook. They knew when they used the textbook workbooks they only had to answer the questions. In the inquiry notebook, however, they needed to write down their thoughts, predictions, the procedure for the experiment, their results, and the reasons or conclusions they came to as a result of their analysis. Students also wrote about similar phenomena from their real life experiences. They all did this in the empty notebook on their own (See figure 4.7) without any prompts or questions (like provided in the textbook workbooks). This photo is shared as evidence of how students began to engage in science inquiry and analysis more independently by using their inquiry notebooks as opposed to the textbook workbooks. This is important because it means that my students were engaging in more student-centered inquiry activities as a result of the changes we instituted in our classroom. Before doing this research, I may not have tried to use my own research notebooks because I would be worried they would not work or that students did not learn as much from the alternative notebook at the one that was sanctioned by the school curriculum. My experiences in cogenerative dialogues and in examining video from our science lessons showed me that my students were actively engaging in science – so I was able to continue taking risks in my teaching.

Figure 4.7 Students writing down something on the inquiry notebook

After the cogenerative dialogue and checking the students' thoughts by reviewing their research notebooks, I became more convinced that students were agreeing with my ideas about the research and that they were willingly participating in the research. They knew they were doing "inquiry" by themselves using their inquiry notebook. Doing something else instead of the workbook, which was published by the government and used in every elementary science class was hard decision for me as a beginning teacher. I was afraid of failure. But cogenerative dialogue with my students helped me to feel comfortable to create a new teaching strategy.

Similarly, when I checked students' feedback about my use of the 5E Learning Model for restructuring my lessons, I found my students could see the consistency in the flow of my science class and they were getting used to it. This made me really happy because by becoming aware of the model, I felt that my students would be better able to do inquiry using the 5E model when they experienced scientific phenomena in their own lives. I also hoped my students' awareness of the 5E model would increase their ability to do inquiry by themselves without the assistance of the teacher or their peers. In an effort to determine how effectively my students understand my purpose for using the 5E Learning Cycle model and whether they could follow the process independently, I asked them to reflect on the model in their notebooks. The followings are excerpts from students' research notebook about the 5E learning model written during Cogen_W1.

> "Using five steps in science class has helped me understand things more easily. At the first step[14], we saw a video clip, but I didn't know what it was clearly. But as we went through each step, I was able to understand it more clearly and finally I was able to enjoy the science class more than before."
>
> (JW's research notebook, November 2012)
>
> "At the first step, we saw a video clip from a famous show. It was fun and I could see the science in that movie clip."
>
> (JH's research notebook, November 2012)

[14] Engagement

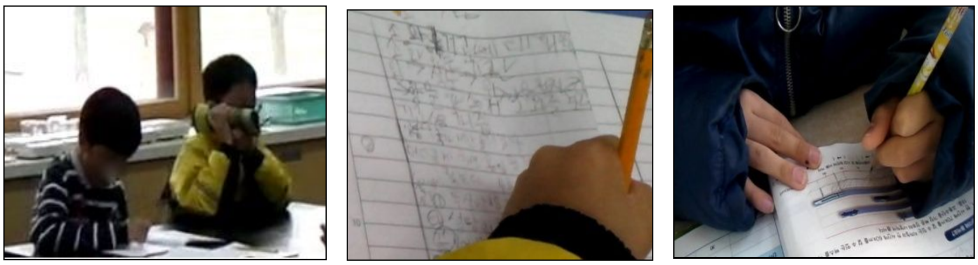
> "Since we watched an interesting video related to our study, it was more interesting and I wanted to know more after watching it."
>
> (CY's research notebook, November 2012)
>
> "Doing an evaluation at the end of the each class was helpful. We were able to check on what we learned today."
>
> (HY's research notebook, November 2012)

These entries are evidence that students were able to understand the purpose of each step and that they were beginning to be able to understand the activities we engaged in during each step. They knew I was using different kinds of references to make them engage in the lesson and to pull from their own previous knowledge to help them construct meaning about science concepts. Some of the students provided even more feedback about the Evaluation step, saying that they appreciated this step because it allowed them to check what they had learned for the day and that this was very helpful. Other students suggested that I use different tools, such as PowerPoint, to show them even more pictures and to help them to organize their knowledge during the Explanation step.

They were not just giving me their thoughts, but also supporting my strategy. I began to feel confident to try something new. This is important for new teachers who are often afraid of failure and losing control of the classroom because of the failure. Cogenerative dialogues help teachers establish relationships with their students, which support them to take risks with their teaching.

4.2.3 Involving the Low-achieving Student in the Science Lesson

As I mentioned in previous chapter, DH was the student I was most concerned about during the whole school year. After having an individual cogenerative dialogue (Cogen_I1), I tried to be physically closer to him when the students were doing any writing in the science class. As I read the instructions again and explained it to him using easier words, he started to write the answer or his thought in the notebook or workbook. Figure 4.8 shows his change. In figure 4.8 (a), he is playing with his inquiry notebook while classmates were writing. After I warned him and make them follow my instruction on the board, he just copied my writing in unnoticeable Korean character (See figure 4.8 (b)). However, in figure 4.8 (c), he is writing something in his workbook. This was after the Cogen_I1, he felt difficult in writing his own thinking process in Korean so I made him to answer the questions of worksheets. I checked the answer and it was correct.



(a) (b) (c)

Figure 4.8 Change in student engagement: (a) Doing nothing (b) Attempting to do something (c) Completing the task correctly

The changes required time. Encouraging him do something new was not easy. But slowly and finally, he tried to engage in science class even in the writing time. As his friends saw he was doing something during writing time, they also tried to help him to write the answer during the science classroom. In his research notebook, he wrote, “I could enjoy science more. I want to study science with my teacher again”. I was happy that he recognized his changes and he liked the change.

4.3 HITTING A WALL

Even though we tried to change our learning environment and benefit everyone, there were some limits exist which we were not able to overcome in short term or by ourselves. This refers to *Tactical* phase in my research. In this section, I want to share a vignette of tactical phase.

4.3.1 Problems Still Exist

Even though I gave DH more care and spent more time with him to help him engage in science class, he still had difficulty with Korean, and that was his biggest problem. Since he had this big problem, he had trouble organizing and expressing his thoughts. So whenever I gave him a chance to speak, I had to reorganize what he said in order for him to be understandable to the other students. I had to interpret his writing to guess his intent and sometimes I could not even recognize the letters he wrote down. Since I believed his problem with Korean could cause severe issues and that these problems would accumulate as he went into higher grades I encouraged him practice his Korean after class.

He was a student who got support from school. He was having counseling and play-psychotherapy once a week. The counselor told me that he was in very unstable emotional state, especially regarding his relationship with his father. He also has difficulty in controlling his anger. At that time, I had a chance to visit his home with the social worker in school. I wrote this reflection in my notebook:

> "I experienced a feeling of helplessness after I saw with my own eyes that there's nothing more I can do for this poor child."
>
> (Teacher field notebook after visiting a student's home, December 2012)

This excerpt shows my despair after realizing my limits to help this student. I tried with to improve my science teaching and his science learning and we were able to implement some positive changes. However, additional progress for this student looked impossible. That was a situation that I didn't expect when I first designed my research. This told me something more needed to occur in order for our research to affect any real and sustainable changes that were more far reaching that our science classroom.

4.3.2 Beyond My Scope

DH was living his parents and two brothers, and was the middle of three boys. His mother is Japanese. She can speak Korean quite fluently but she is not good at writing. His father offers no support in any way, including financially. He has a job, but he spends money only on himself. So DH's mother has to make the money required for living and to raise all three of her boys by herself. She works every other day, but on the days that she works, she does a 24-hour shift. This means when she gets home, she is too exhausted to take care of her sons. As a result, they often miss breakfast and often wake up late and are late to school. DH's father often hits his mother and him. His mom said that his father thinks that DH is the "most stupid son" among the three siblings so he speaks to DH severely and ignores him.

The school counselor confirmed all of the details and it made sense to me based on these findings that DH would have many difficulties in school. The majority of his troubles were rooted in his home life, but they had a big affect on his ability to perform well in school and in science. He barely had a chance to learn Korean from his parents. He was not able to eat well in his house. The lunch that he ate in school was the only chance he had to eat properly in the entire day, which is why he ate a large amount. The students often teased him for eating several portions of lunch, so these issues from home also affected his social interactions with his peers.

When I visited his home to discuss his problem with his family and to find a solution, I had not anticipated the extent of his challenges. In the end, I was not even able to talk about issues in our science class. Involving his mother to talk about these issues was beyond my reach. I came to realize that a student's life involves more than in my 40-minute class and I came to see that there are some things that I cannot change. It made me feel hopeless, but I felt compelled by the *tactical* authenticity criteria that structured our research to try to do something to help him. Even though many things were out of my reach, within the realm of the school, I decided to do whatever I could to support him to succeed. At the end of the school year, I applied to be his homeroom teacher for the next school year in an effort to give him continued support, but because of school policy, this was not possible. The school encourages that students have a different homeroom teacher every year in order to experience new environments and avoid discrimination and favoritism. Usually we pick classes randomly at the beginning of the school year. There are some special cases, but those cases are mostly relevant to the students who have disabilities or serious problems, and DH was not considered to belong to one of those cases. Children who were considered special cases were also usually assigned to experienced teachers rather than beginning teachers. So, in the end, I was not able to support him as I had intended.

But, I learned a great deal form this experience – especially I realized that my responsibility as his teacher was not just to teach science, but also to teach the whole child. I recognized that some children have a lot of problems and need more help – maybe even more help than I can give. I needed to better understand the community, home, and student. Before this research, I never considered these issues when thinking about planning my lessons and teaching science. But this experience helped me understand that if I really wanted to expand my GPK *in the classroom,* I would need to learn more about my students *outside of the classroom*. This has radically changed how I view my responsibility as a teacher.

4.4 CONCLUSION

This chapter examined the role of cogenerative dialogue in altering classroom practices by changing my teaching practices, setting new rules in our class, and learning to appreciate the roles that teachers must play in supporting students as learners both inside and outside of the classroom. Data analysis of student conversations, video interactions, and cogenerative dialogue allowed us to identify several issues of importance to my students and me. My students and I learned about one another's needs during these conversations. As my students and I exchanged our thoughts about class and about what best supported their learning, they also became more active in helping each other and me! As a result, I found I was no longer isolated in my struggle to teach science. We began to strategize as a group about how best to implement change. Afterwards, we came together again to reflect on the changes we made. By constantly monitoring our changes and our new experiences as a result of these changes, we were better positioned to solve our problems together. This is the real power associated with engaging in cycles of *catalytic* dialogue with students. As we continually made changes, evaluated our changes, and revised our classroom, we gained more confidence in our abilities and we became more trusting of one another. By engaging in these dialogues with one another, we discovered things not only about one another, but also about ourselves. The students began to identify strategies that they felt supported their learning and shared them with their peers. In this way, both teachers and students began to transform the classroom in many ways. However I also recognized there are some limits to the teacher's ability to effectively support students in the classroom. An issue of *tactical* authenticity emerged during the research, which I found impossible to solve in the science classroom. In the final chapter, I examine the limitations of this research in greater detail.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

"I'm not alone."

(Changmi field notebook, December 2012)

This is the final entry I made in my field notebook. This sentence is very simple, but it highlights one of the most significant findings of my research.

In this concluding chapter, I re-examine the findings from this study in conjunction with the questions posed at the beginning of this thesis and in the broader context of the current state of education. In doing so, I revisit some of the challenges associated with teacher education related to PCK as introduced in the first chapter. I pay particular attention to the difficulties experienced by beginning teachers referring to PCK and I discuss limitations of this study before presenting a case for cogenerative dialogue as a pathway for transforming science teaching and learning in the beginning teacher's elementary science classroom. Finally, I offer implications that these findings raise for teacher education programs and for reforming educational policies at the school and community level.

5.1 SUMMARY

For a teacher to be successful as an educator, they need to be able to draw from a diverse pool of knowledge and strategies to engage their students, manage their interactions while implementing effective pedagogical strategies, and support students to construct conceptual understandings about specific content. To do this, teachers require several forms of knowledge, including General Pedagogical Knowledge (GPK). GPK includes knowledge of theories of learning and general principles of instruction, an understanding of the various philosophies of education, general knowledge about learners, and knowledge of the principles and techniques of classroom management. Unfortunately, pre-service teachers have limited chances to equally develop these forms of knowledge through their teacher education programs and during their teaching practicum experiences. Instead, teacher education programs tend to focus on developing science subject matter knowledge, rather than knowledge related to experiential teaching.

Once these students become beginning teachers, they find themselves isolated in their teaching, spending time only with their students and having limited opportunities to engage in professional development with peers. As a result, many beginning teachers find that they themselves have to solve their own problems, often resorting to trial and error tactics because they were not educated about how to engage in research on their own practice in their teacher education programs. To improve my PCK about students as learners, I thought it was essential to invite my students to participate in my research and for us to try to improve science teaching and learning together in our own classroom.

Thus I started an action research project in which I engaged students in my 5th grade science class as co-participants to help me transform my class teaching practices. To date, considerable research in the field of science education has shown that cogenerative dialogue is a powerful tool for helping teachers and students to build relationships that provide them a chance to talk about school and science class in an effort to improve teaching and learning. While many studies have used cogenerative dialogues and discussed their benefits, no studies have examined the process of cogenerative dialogue in conjunction with teacher development of PCK. In addition, no research has examined the effectiveness of action research by a beginning teacher using cogenerative dialogue in to improve science teaching in a Korean elementary classroom.

For these reasons, in this study, I examined the effectiveness of using cogenerative dialogue as part of a collaborative action research project. Specifically, I explored how this tool helped me to develop targeted domains of my PCK, which in turn, enabled me to improve my science teaching. This research provides evidence of the ways in which cogenerative dialogue can support beginning teachers to engage in participatory research with their students in an effort to build their knowledge about how to effectively teach their students beyond what they learned as pre-service teachers.

5.1.1 Setting and Design of the Study

This action research focused on improving PCK of beginning teacher in the elementary science classroom. Conducted within the methodological framework of action research, this research examined the ways in which beginning teachers can engage students in collaborative research efforts with my students to overcome the isolation beginning teachers experience and to work individually and collectively to resolve problems in classroom teaching and learning. I used Guba and Lincoln's (1989) authenticity criteria as a framework for tracing my changing PCK in the four stages of the cogenerative dialogue process.

The study was situated in my fifth-grade science classroom in an urban elementary school which is an "education welfare-invested school" and whose overall student achievement is very low. Participants included all 25 students in the class, a university researcher (Martin and Park) and me as a teacher-researcher. The research was conducted in the classroom and the laboratory room during second semester in 2012. Student research notebooks, teacher field notes, video captured from science lessons and cogenerative dialogues, and interviews with students were collected as data.

5.1.2 Focus of the Study

In this study, I examined the effectiveness of using cogenerative dialogue as part of a collaborative action research project and, specifically, I explored how this tool helped me to develop targeted domains of my PCK that serve to improve my science teaching. The following two overarching research questions guided my research:

1. What can teachers and students in elementary classrooms learn from one another by engaging in cogenerative dialogues?
2. How can what teachers learn from cogenerative dialogues and how does what they learn enable them to improve science teaching and learning to improve PCK?

Answered in chapters 3 and 4, these questions served to frame my inquiry into my teaching with my students. In an effort to organize and discuss the findings that were most relevant to my research in this final chapter, I briefly re-visit the themes that emerged from my study in this section, namely: a) Teachers can expand and reinforce the development of their PCK while being supported by their students, b) Teachers and students can build positive social relationships and increase achievement in science and improve student and teacher enjoyment with school and science, c) Engaging in these conversations helps teachers recognize that there are many problems beyond the classroom.

5.2 LIMITS OF THE RESEARCH

As explained earlier, this study was unique because it involved a beginning elementary science teacher who engaged young children in cogenerative dialogues about how to improve science teaching and learning in their own classrooms. While other studies have been conducted between teachers and students using this method for engaging in dialogue about how to change teaching and learning – no studies have been conducted by beginning teachers at the elementary level and none have been done in the context of a Korean elementary school. As a result, I had limited examples from the research about how to most effectively facilitate these dialogues.

Three of the most salient limitations I note from this study are related to the a) content of the dialogues, the b) challenges associated with cultural expectations for interactions between students and teachers in Korean society, and c) challenges related to addressing issues of individuals and the collective. I expand upon these limitations in the sections that follow and I offer suggestions for how to overcome these limitations for future researchers.

5.2.1 Content of the Dialogues

The focus of the cogenerative dialogues was somewhat concentrated on issues related to GPK – classroom management, instructional principles, learners and learning. For example, my students and I made new rules and changes to re-structure our science class. And this is strongly related to the needs of beginning teachers. There was not experience and time for both students and me to be able to integrate all the forms of knowledge to spend more time focused on content specific issues. However, this is necessary for before teachers to have a handle on before they can focus on PCK focused issues.

If beginning teachers continue to utilize this tool, they can work with their students to address the initial problems limiting their success in school – which may be focused on non-science specific issues – but after doing this over time, teachers and students will be able to shift their focus to other issues, such as science content knowledge.

5.2.2 Challenges Associated with Cultural Expectations for Interactions between Students and Teachers in Korean Society

Many instructional strategies have been developed in other countries with different cultural contexts and social norms that shape how teachers and students interact in classrooms. This research was no exception, but this study has shown cogenerative dialogues can be effectively implemented in Korea. But, there were some challenges - students were reluctant at first to speak, and were afraid to be critical. In Korean contexts, there are strong expectations about how students should speak with teachers root in Confucianism as I mentioned in previous chapter. And this may be an issue that would need to be addressed by all teachers. To overcome this I kept reminding them it is okay, valued what they said, implemented their actions, did not retaliate for what they said. As I kept showing them my strong belief and putting in to action, they started to talk about the problems.

Cogenerative dialogue can be effective in Korea, but teachers and students may have to pay explicit attention to discussing how we are "expected" to talk in everyday life and how this research encourages us to change that - but that it is not asking us to abandon being respectful of one another - so maybe it is compatible. A limitation would be whether a teacher would be willing to take on this role and share responsibility with students for examining the classroom and changing it.

5.2.3 Challenges Related to Addressing Issues of Individuals and the Collective

This research was mostly focused on whole class more than individual. If beginning teachers once do this type of research. Limitation could be related to cultural expectation that we address the needs of the collective over the individual. But tactical authenticity requires that teachers consider the needs of individuals as well as the collective. If I would have had more cogenerative dialogue with DH and his mom, I might be able to find better way to help this academic improvement. And there might be different way to improve my science class environment if I had cogenerative dialogues with girls or high-achieving students.

Teachers need to find a balance that is suitable for their research, their specific class context, and that continues to reflect the authenticity criteria - especially the requirement to be tactical. Not easy to do, but if teachers and students use the criteria as a framework for their interactions, they will be reminded to consider this explicitly.

5.3 CONCLUSIONS

5.3.1 The Importance of Cogenerative Dialogue in the Classroom

Cogenerative dialogue is effective method in allowing teachers and students an opportunity to talk about aspects of school and to change their learning practices. In this way teachers can expand and re-inforce the development of their PCK while being supported by their students. In addition, teachers and students can build positive social relationships that allow them to take risks with one another and try new teaching and learning strategies that can increase achievement in science and improve student and teacher enjoyment with school and science. Finally, engaging in these conversations helps teachers recognize that there are many problems beyond the classroom - which require help from parents, administrators, and other teachers to solve. Cogenerative dialogue offers teachers a tool by which to engage these other stakeholders in dialogue to help address problems that can prevent students from being successful in school and science. By expanding the circle of people involved in supporting students, teachers can better support their students both inside and outside of the classroom.

5.3.2 How Can Teachers Use the Cogenerative Dialogue

Teachers can help students to access and understand the social dynamics in the classroom, which is needed if students are to successfully engage in collaborative inquiry activities, argumentation or other socially focused activities in the science classroom. If we want teachers to be successful in using inquiry, argumentation or other instructional strategies, then we have to provide them some ability to access and understand the social dynamics in the classroom so they can effectively facilitate the interactions between students and their peers.

Today many science education reforms focus on engaging students in constructing science knowledge and meaning from collaborative interactions. For teachers to meet this challenge, they need to understand their learners – but typical classrooms offer teachers and students few opportunities to learn about one another or develop the trust and relationships necessary for students to feel comfortable to actively engage in group-focused tasks. Cogenerative dialogues offer teachers and students a social space to develop their relationships and to build trust with one another. Establishing these relationships is critical for teachers if they are to facilitate and maintain positive interactions in their classroom.

5.3.3 You Are Not Alone

Finally, I learned from this research that, even as a beginning teacher, I did not have to face my problems alone. Using cogenerative dialogues, teachers can look for and find help from the students in their own classrooms. I learned that students could be resource for my learning, if I provide them opportunities to share their ideas with me.

Cogenerative dialogue is a useful tool for helping teachers to share responsibility for teaching and learning with their students. Students have years of knowledge to draw from based on their own experiences in classrooms. If teachers support students to critically reflect upon what they know about how to improve teaching and learning, teachers can capitalize on students as a resource for knowledge and as collaborators who are also invested in making positive changes to the learning environment. Finally, not only does cogenerative dialogue offer teachers a tool for extending responsibility to students, but they can also be used with parents, administrators, and other teachers to help focus on issues that are obstructing teaching and learning from outside of the classroom.

5.4 IMPLICATIONS

5.4.1 Teacher Education and Professional Development

This study suggests a critical point of consideration for teacher educators with regards to how teacher education programs, especially in Korea, may be re-structured to place more emphasis on how to provide pre-service teachers with both the knowledge and experiences they will need to be able to effectively solve challenges they will undoubtedly face as beginning teachers. Specifically, this research supports the need to prepare new teachers to be able to conduct action research in their own classrooms and to be introduced to cogenerative dialogue as tools that will expand beginning teachers' ability to continue to develop their professional practice in the first few years of their teaching.

My experiences conducting action research and utilizing cogenerative dialogues with my students has convinced me that these two can be valuable tools, not only for beginning teachers, but also for veteran teachers who want to improve the teaching and learning in their classroom. In addition, I believe that these tools could support school administrators to address problems at the school-wide level to improve the teaching and learning environment at more systemic levels. These tools could be used to engage parents and communities in more productive partnerships to address challenges faced by both sides as they struggle to support their children to be successful in school.

My research shows that these tools can be transformative at a small scale and I hope that I have a chance in the future to introduce these tools to my school community in an effort to transform issues facing our whole school community. Just as this experience provided my students and me a social space for expressing our ideas and working together to co-generate plans for improving the classroom, by scaling this research up to a larger level – cogenerative dialogues could provide a social space for administrators, parents, and teachers to collectively focus on ways to better support the students in our school.

5.4.2 Implications for Future Research

Citing evidence from the *ontological educative* phases of this research, my thesis shows that participatory action research using cogenerative dialogue could help teachers and students to build positive relationships rooted in trust. Building from this trust, we were able to engage in action in the *catalytic* phase that supported us to make changes to our learning environment that improved students' science learning and that supported me to expand my GPK and to more effectively develop my PCK for teaching science at the elementary levels. Finally, as a result of building trust with one another and learning from one another about our experiences, expectations, and needs, my students and I were able to attend to the *tactical* phase of cogenerative dialogue to help us consider balance the needs of the individual and the collective and to recognize the limits of our ability to make all the changes needed for us to help all individuals to succeed.

The findings of this research have important implications for future studies of teaching and learning in science education. This research is important for all science teacher education programs, but the findings particularly speak to some of the changes necessary for teacher education programs in Korea. Korean researchers and teacher educators may take away from this research the need to reform current teacher education programs to consider how to more effectively engage pre-service teachers in the practical experiences they need to develop *some knowledge* about not only content and instructional strategies (Subject Matter Knowledge), but also about *other forms of knowledge (General Pedagogical Knowledge).* Currently the pre-service teachers in Korea have limited opportunities to engage in real teaching experiences where they can develop *forms of knowledge*. In addition, pre-service teachers have limited opportunities to *learn about action research, conduct research as teachers, etc.*

Because these issues are not specific only to teacher education in Korea, other educators and researchers may also benefit from re-framing teacher education programs to expand opportunities for pre-service teachers to engage in extended teaching practicums, to conduct action research projects, and to be introduced to cogenerative dialogue as a particularly effective tool for engaging students in classroom-based participatory action research. Globally, researchers may choose to focus future research efforts on how to more effectively engage beginning teachers and their students in conversations that move beyond issues related to general pedagogical knowledge problems to focus more exclusively on issues related to content specific pedagogy which can help enhance beginning teachers' PCK. Finally, the research on cogenerative dialogues has been done almost exclusively in learning environments with very diverse student populations in educational contexts that are culturally quite different from Korea. Additional research is necessary for helping us to better understand how culture influences the ways in which students and teachers conduct cogenerative dialogues and how differences in how they use this tool may diminish its effectiveness. Understanding the role of culture in determining how teachers and students engage in cogenerative dialogues to improve science teaching and learning is an important area for future study.

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국문 초록

초등과학수업에서 초임교사의 PCK향상을 위한 Cogenerative Dialogue 활용 현장연구

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교사양성전문기관에서 교육을 받고 높은 경쟁을 뚫고 초등임용고시에 합격한 초임교사는 교육현장에 입문하며 교육과정 운영에 대한 자신감 부족, 학급경영을 잘 하고 있는가에 대한 불안감, 그리고 행정업무에 대한 중압감 등 여러 가지 어려움에 당면하게 된다. 이러한 문제를 해결하기 위해서 여러 방법을 모색하려고 노력하지만 학교문화에서의 고립감과 안내 부재, 이론적 지식습득 위주의 교사 연수 과정의 한계로 인해 스스로 문제를 해결하기가 매우 어려운 실정이다.

본 연구는 초임초등교사가 자신의 과학교수방법 개선을 위하여 교수내용지식(PCK)을 향상시킬 수 있는 방법을 활용한 현장 연구이다. 본 연구에서는 교수내용지식을 이론적 틀로 사용하여 초임교사가 전문성 개발을 위한 교수의 실제를 분석하였다. 이를 통해 학생들이 연구자로

참여한 연구가 초임과학교사의 고립적 상황을 극복하고 교수내용지식의 향상에 기여했는지 파악하고자 하였다. 또한 본 연구에서는 과학 교수학습의 개선을 위한 실천 방법이자 연구 방법으로 공동생성적 대화(Cogenerative Dialogue)를 활용한 연구를 진행하였다. 공동생성적 대화란, 과학수업에 참여한 당사자들(stakeholders)이 교사, 학생, 연구자 등이 과학 교수학습에 대하여 각자의 경험을 공유하면서 각 당사자들의 입장을 비판적으로 듣고 이를 통하여 과학 수업의 개선점을 도출하고 실천하는 수단으로서 사용된다. 공동생성적 대화는 전체 참여 대화, 소그룹 대화, 일대일 대화 등 다양한 형태로 진행이 되었으며, 학습자로서의 학생에 대한 지식, 과학적 탐구를 증진시키기 위한 과학수업 경영에 대한 지식, 효율적으로 과학수업에 적용할 수 있는 탐구교수방법에 대한 지식 등 교사의 과학수업에서 내용교수지식을 향상시키기 위한 목적으로 활용하였다.

공동생성적 대화를 일반적인 교실 토론이나 자료수집 방법으로서 일반적인 면담과 구별짓는 특징이자, ‘공동생성적’인 실천 방법이자 연구 방법으로서 타당하게 해주는 준거는 Guba와 Lincoln(1989)의 진정성 준거(authenticity criteria)로부터 도출할 수 있다. 단지 해석적 연구가 연구로서 타당성을 갖기 위한 준거일 뿐 아니라 교육 연구와 같이 인간의 사회 활동을 대상으로 하는 연구가 갖추어야 할 윤리적 규범이자 지향을 제시하고 있는 이 진정성 준거를 바탕으로 연구를 분석하였다.

본 연구는 2012년 4개월 동안 서울 도심의 교육복지특별지원 학교인 J 초등학교의 5학년 25명의 학생들을 대상으로 교실과 과학실에서 진행된 모든 수업을 바탕으로 녹화된 영상자료, 녹음된 음성 자료, 교사의 현장노트, 학생의 연구노트, 공동생성적 대화, 대학연구자와의 연구회의 등의 모든 내용이 자료로 사용되었다. 학생들은 모두 연구참여자로 연구활동에 기여하였으며, 초등초임교사인 연구자와 대학 연구자가 함께 참여하였다.

결론적으로, 본 연구에서 학생들의 적극적인 참여를 통해 이루어진 과학수업에 대한 공동생성적 대화는 초등학생들이 학교, 과학, 과학교수학습 방법에 대해 가지고 있는 생각에 대한 통찰력을 배양할 수 있는 가치 있는 기회를 제공함으로써 초임초등교사의 내용교수지식을 함양하는데 공헌하였다. 뿐만 아니라 학생들은 자신의 수업을 스스로 개선하는 데 기여할 수 있는 기회가 제공되었을 때, 그들은 문제해결과정에 참여하고 교사의 교수 전략이나 학생들의 참여를 향상시킬 수 있는 제안을 함으로써 자아효능감을 배양할 수 있었다.

이러한 결과는 교사 교육 프로그램이 초등초임교사들에게 현장 연구를 하는 방법, 공동생성적 대화를 실행할 수 있는 방법 등을 강조한 실제적 노력을 통해 초임교사들이 그들의 과학교실에서 성공적으로 교수활동을 하는 데에 공헌하는 바가 클 것이다.

주요어 : 초등초임교사, 교수내용지식(PCK), 현장연구, 과학수업,
공동생성적대화(Cogenerative dialogue), 진정성 준거
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