INVESTIGATION OF PRE SERVICE SCIENCE TEACHERS' PERCEPTIONS RELATED TO PEDAGOGICAL KNOWLEDGE AND PEDAGOGICAL CONTENT KNOWLEDGE

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ABSTRACT

INVESTIGATION OF PRE SERVICE SCIENCE TEACHERS PERCEPTIONS RELATED TO PEDAGOGICAL KNOWLEDGE AND PEDAGOGICAL CONTENT KNOWLEDGE

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The purpose of the present study was to investigate the pre service science teachers' perceptions related to science teaching. Within this scope, participants' perceptions related to their pedagogical knowledge (PK) and pedagogical content knowledge (PCK) were examined. Furthermore, it was aimed to investigate the effect of gender and level of achievement on participants' perceptions regarding PK and PCK. 176 fourth year pre service science teachers from three state universities of Ankara participated in the study. The design of the study was planned as survey and two questionnaires were administered to the participants in order to collect data. Data obtained from the questionnaires were analyzed by using both descriptive and inferential statistics.

The results of the study revealed that pre service science teachers perceived themselves as competent in terms of both PK and PCK. When components of PK

were examined, participants' perceptions were high regarding classroom management, learners and learning, lesson planning and assessment. With respect to components of PCK, participants perceived that they had high level knowledge of science instructional strategies, knowledge of science learners, knowledge of science misconceptions, knowledge of science curriculum and knowledge of science assessment. Moreover, no significant difference was found between female and male participants' perceptions pertinent to PK and PCK. It was also observed that level of achievement did not make any difference on pre service science teachers' perceptions related to PK and PCK.

Keywords: Pre service science teacher education, science teaching, pedagogical knowledge, pedagogical content knowledge

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ PEDAGOJİK BİLGİLERİNE VE PEDAGOJİK ALAN BİLGİLERİNE İLİŞKİN ALGILARININ İNCELENMESİ

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Bu çalışmanın amacı fen bilgisi öğretmen adaylarının fen öğretimine ilişkin algılarını incelemektir. Bu kapsamda katılımcıların sahip oldukları pedagojik bilgilerine (PB) ve pedagojik alan bilgilerine (PAB) ilişkin algıları araştırılmıştır. Ayrıca bu çalışmada fen bilgisi öğretmen adaylarının cinsiyet ve akademik başarı durumlarının PB'lerine ve PAB'larına ilişkin algılarına etkisini incelemek amaçlanmıştır. Çalışmaya Ankara'da bulunan üç devlet üniversitesinden 176 dördüncü sınıf fen bilgisi öğretmen adayı katılmıştır. Çalışma tarama deseni olarak planlanmıştır ve veri toplama amacıyla katılımcılara iki anket uygulanmıştır. Anketlerden elde edilen verilerin analizi betimsel ve çıkarımsal istatistik kullanılarak yapılmıştır.

Çalışmanın sonuçlarına göre fen bilgisi öğretmen adayları PB ve PAB konusunda kendilerini yeterli olarak algılamışlardır. PB'nin bileşenleri incelendiğinde katılımcılar sınıf yönetimi, öğrenme ve öğrenci, ders planlama ve değerlendirme konularındaki bilgilerini yeterli bulmuşlardır. PAB'ın bileşenleri (fen öğretim stratejileri bilgisi, öğrencilerin feni anlamalarına yönelik bilgi, fen programı bilgisi, öğrencilerin kavram yanılgılarına ilişkin bilgi ve fen öğretiminin değerlendirilmesi bilgisi) ele alındığında, benzer şekilde katılımcıların bu bileşenlerde de algıları yüksektir. Ayrıca, kadın ve erkek katılımcıların PB ve PAB'a yönelik algılarının arasında anlamlı bir farklılık bulunamamıştır. Akademik başarı durumlarının da fen bilgisi öğretmen adaylarının PB ve PAB konusundaki algılarında bir fark yaratmadığı gözlemlenmiştir.

Anahtar Kelimeler: Fen bilgisi öğretmen eğitimi, fen öğretimi, pedagojik bilgi, pedagojik alan bilgisi

To My Family

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LIST OF ABBREVIATIONS

PK	Pedagogical Knowledge
PCK	Pedagogical Content Knowledge
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
TPACK	Technological Pedagogical Content Knowledge

CHAPTER I

INTRODUCTION

1.1. Background to the Study

In the developing world, scientific and techonological innovations has grown rapidly and people in the society need to apply and extend innovations. Therefore, it is inevitable to teach science according to the needs of 21st century skills and people should have adequate knowledge related to science and technology in order to follow these innovations (Organization for Economic Co-operation and Development [OEDC], 2009). Science education has a key role in order to encourage elementary school students' to be involved in scientific and technological world and in many countries it has been recognized that there is a growing demand for scientifically literate people (ICSU, 2011). Scientific literacy has used as an important goal of science education (American Association for the Advancement of Science [AAAS], 1993). According to Laugksch (2000), having high level of scientific literacy have benefits both for nations and for individuals. Nelson (1999) noted that "without a science-literate population, the outlook for a better world is not promising" (p.14). Similarly with the international literature, scientific literacy is given importance in Turkish curriculum and Ministry of National Education (MoNE) in Turkey described the vision of elementary science curriculum as "raising all the students as scientifically literate persons" (2013a, p.1). Moreover, since scientific literacy is crucial for science education, it is needed to understand the characteristics of scientifically literate person. National Research Council (NRC) indicated the characteristic of scientifically literate person as "person can ask, find, or determine answers to questions derived from curiosity about everyday experience … can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed" (1996, p. 22).

There are some international studies that evaluate education systems and make comparison between countries and Turkey usually get some disappointing results from these studies. One of these studies, PISA (Program for International Student Assessment), has applied paper based tests to 15 years old students and assessed them in terms of science, mathematics and reading every three years since 2003. Results from science tests revealed that despite the fact that Turkish students' have improved their scores in mathematics and science, they are still not able to reach OECD average (OECD, 2013). Another international comprehensive study named TIMMS (Trends in International Mathematics and Science Study) is held every four years and assesses 4^{th} and 8^{th} grade students' achievement in science and mathematics. Results on science for both grades indicated that Turkish students' performance were below the average (TIMSS, 2011). In addition to the PISA and TIMSS results, in exams that provide transition from elementary schools to the high schools in Turkey, elementary school students generally have low level of achievement in science. To illustrate, according to the results of the SBS (High Scool Entrance Exam) exam held in 2012, Turkish elementary school students' overall mean value for questions in the science exam was 6.22 out of 20 (MEB, 2013b). Hence, it is seen that Turkish elementary school students achievemet level in science was low both in international and national assessments. Furthermore, Büyüköztürk, Çakan, Tan and Atar (2014a) mentioned in TIMMS national report that the scores of 4^{th} grade students who attended TIMSS in Turkey, differ by whether their teachers who graduated from faculty of education or not. The scores of students whose teachers graduated from faculties of education were better than the other students. Therefore, since the teacher has influence on students' achievement, teacher education gains importance (OECD, 2011).

The role of teachers has great influence on student learning (Darling-Hammond, 2000; McKenzie, Santiago, Sliwka & Hiroyuki, 2005) and therefore research studies regarding teacher knowledge are important (Aydın, 2012). For more than 50 years, science teacher knowledge has been the focus of research and studied in different ways by many researchers (Abell, 2007; Bruce, 1971; Cochran-Smith & Lytle, 1993; Reynolds, 1989). In 1986, Shulman introduced a teacher knowledge model including

three domains: pedagogical content knowledge (PCK), curricular knowledge and content knowledge. One year later, Shulman (1987) added general pedagogical knowledge (GPK), knowledge of educational context, knowledge of learners and their characteristics, knowledge of educational ends, purposes and values and their philosophical and historical grounds as other categories of teacher knowledge. After Shulman, other researchers proposed different models of teacher knowledge (Abell, 2007; Cochran, King, & DeRuiter, 1991; Magnusson, Krajcik, & Borko, 1999). Moreover, based on Shulman's work, they introduced some new components of PCK like orientations to teaching science, knowledge of assessments etc. In this study, Abell's (2007) science teacher knowledge model is used as a framework which was given in detail in the following section. In this model teacher knowledge includes four different domains namely; pedagogical content knowledge, pedagogical knowledge, subject matter knowledge and knowledge of context in this model. Both PK and PCK are investigated with respect to how pre service science teachers perceive them in the current study.

Pedagogical content knowledge (PCK) refers to "blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interest and abilities of learners and presented for instruction" and "It is the category most likely to distinguish the understanding of the content specialist from the pedagogue" (Shulman, 1987, p.8). Moreover, specifically for science education, National Research Council (1996) described PCK as "special understandings and abilities that integrate teachers' knowledge of science, content, curriculum, learning, teaching and the students" (p.62). It is the knowledge specific to teachers and distinguish them from biologists, chemists etc. To illustrate, a scientist does not have to deal with how to teach the subject whereas teachers need to use their PCK in order make the subject accessible to learners with the help of analogies, illustrations and so on (Yiğit, 2009). There are different PCK models in the literature which is given in detail in the next chapter. Four components of PCK are included in the current study as follows: knowledge of science instructional strategies, knowledge of science assessment, knowledge of science curriculum and knowledge of science learners.

Ball (2000) mentioned that teachers have problems in integrating their knowledge of content and PK and thus PCK is a crucial construct since it combines content and pedagogy (Anderson & Mitchener, 1994). Pre service science teachers are anticipated to combine the knowledge gained from content and pedagogy courses with the help of practicing experiences in real classrooms especially in their final years of education. Furthermore, teachers need to have knowledge in terms of which subject they teach but this might not be adequate while teaching; the fundamental point is to make the subject comprehensible to the students (Ball, Thames & Phelps, 2008). Similarly, Kind (2009) stated that teacher with strong SMK is not enough to teach. It means that having sufficient knowledge in a particular science topic does not imply teachers could make the topic understandable for students.

As Friedrichsen (2008) points out instead of introducing new concepts for investigating science teacher knowledge, PCK and its components should be used in practice and in studies. There are many studies in the literature looking at pre service teachers' PCK from different perspectives. Some of them concentrate on the development of PCK (Adadan & Oner, 2014; Brown, Girotto Júnior & Fernandez, 2013; Friedrichsen & Abell, 2013; Hume & Berry, 2011; Nilsson & Loughran, 2012) while others focus on the nature of the components of PCK (Aydin, Demirdöğen, Akin, Uzuntiryaki-Kondakci & Tarkin, 2015; Kaya, 2009) and the relationship between SMK and PCK (Canbazoğlu, Demirelli & Kavak, 2010; Ding & Leung, 2014; Uşak, 2005). Additionally, PCK studies have mostly been performed with pre service teachers and the number of studies which include teaching assistants or teacher educators PCK is limited (Aydın & Boz, 2012).

There are some challenges that researchers encountered when studying PCK. Aydın and Boz (2012) specified that PCK is not a simple construct and in order to have a comprehensive understanding of PCK, longitudinal studies should be preferred. They also stated that it is difficult to make distinctions between PCK components. Moreover, Ball, Thames and Phelps (2008) indicated that "what is meant by pedagogical content knowledge is underspecified; the term has lacked definition and empirical foundation, limiting its usefulness" (p.389). Abell (2008) mentioned two

main challenges when studying science teachers' PCK. She indicated that the relationship between PCK and student learning is still not clear and studies are carried out with smaller samples. In addition, Baxter and Lederman (1999) point out one of the main challenges is that difficulties in observing PCK since it is an internal construct, it cannot be directly observed. He further discuss that qualitative studies related to PCK are long-term studies and analyzing the data is difficult for the researcher and it takes long time. To sum up, PCK is a useful framework and has been used by many researchers but because of the above mentioned reasons, there are some challenges that researchers face when studying PCK.

Pedagogical knowledge (PK) is the other domain of teacher knowledge included in the present study. Shulman (1987) described it "general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter" (p. 8). According to Abell (2007) it includes knowledge of instructional principles, classroom management, learners and learning, educational aims which are generic knowledge, in other words, PK is not specific to any subject. This means that all pre service teachers from different departments of education faculties such as computer education and instructional technologies, Turkish language teaching so forth should have this type of knowledge. Morine-Dershimer and Kent (1999) indicated that PK is essential for teaching the content effectively and pre service science teachers should have knowledge related to classroom management techniques, managing students with different needs, using a variety of instructional strategies. Pre service teachers need to develop their PK in order to handle difficult classroom situations, understand how students learn and how to support student learning, increase students' attention to the learning and stimulate their thinking while teaching the subject. According to Koehler and Mishra (2009) "a teacher with deep PK understands how students construct knowledge and acquire skills and how they develop habits of mind and positive dispositions toward learning" (p. 64). Furthermore, since the ability of the effective teaching depends upon teachers' perceptions of their PK (Choy, Lim, Chong & Wong, 2012), understanding pre service teachers' perceptions regarding PK is crucial.

Although PK is described similarly in different studies (Garrahy, Cothran & Kulinna, 2005; Koehler & Mishra, 2009; Shulman, 1987) there are some differences in the definition of components of GPK (Voss, Kunter & Baumert, 2011). To illustrate, Voss, Kunter and Baumert (2011) accepted classroom assessment, classroom management, teaching methods and learning process and individual characteristics as components of GPK whereas Wong, Chong, Choy and Lim (2012) preferred to use classroom management, student learning, instructional support, lesson planning, accommodating diversity, and care and concern as components of GPK in their study. On the other hand, Abell's (2007) model of teacher knowledge categorized GPK under four components: learners and learning, classroom management, instructional principles and educational aims. Therefore, it could be said that in the literature studies regarding PK differ in terms of its components. Konig (2013) mentioned that there are limited studies in the literature regarding GPK of pre service teachers and thus what is included in the dimensions of GPK is still open to dispute.

1.2. Purpose of the Study

The purpose of the study is to present pre service science teachers' perceptions pertinent to science teaching. In line with the purpose, their perceptions related to their pedagogical knowledge and pedagogical content knowledge is investigated together. The following research questions and sub-research questions guide the current study:

1. What are pre service science teachers' perceptions related to their pedagogical knowledge?
    1.1. Do pre service science teachers' perceptions related to their pedagogical knowledge and its dimensions (learners and learning, lesson planning, classroom management and assessment) differ in terms of gender?
    1.2. Do pre service science teachers' perceptions related to their pedagogical knowledge and its dimensions (learners and learning, lesson planning, classroom management and assessment) differ in terms of level of achievement?

2. What are pre service science teachers' perceptions related to their pedagogical content knowledge?
   2.1. Do pre service science teachers' perceptions related to their pedagogical content knowledge and its dimensions (knowledge of instructional strategies, knowledge of learners, knowledge of assessment, knowledge of curriculum) differ in terms of gender?
   2.2. Do pre service science teachers' perceptions related to their pedagogical content knowledge and its dimensions (knowledge of instructional strategies, knowledge of learners, knowledge of assessment, knowledge of curriculum) differ in terms of level of achievement?

1.3. Significance of the Study

Pre service science teachers need to be well prepared in terms of "how to teach science" in order to increase students' interest towards science (Meriç & Tezcan, 2005; Nezvalova, 2011). Furthermore, it is essential to understand how pre service teachers improve their theoretical and practical knowledge and how they connect these knowledge domains when teaching (König, 2013). For that reason, determining of student teachers' knowledge has great importance and implications for science teacher education.

Pre service science teachers' knowledge is studied with respect to their perceptions related to PK and PCK in this study. In the literature, studies related with teacher knowledge mostly focus on PCK and SMK and general pedagogical knowledge (GPK) is given less importance (König, 2013; König, Blömeke, Paine, Schmidt & Hsieh, 2011; OECD, 2012; Voss, Kunter & Baumert, 2011; Willson & Berne, 1999). The results of the study are expected to contribute to the gap in the literature by yielding results significant to eliciting perceptions of pre service teachers related to PK.

Moreover, PK studies are mostly carried out with pre service mathematics teachers in the international context (Blömeke, Paine, Houang, Hsieh, Schmidt, Tatto, Bankov,

Cedilllo, Cogan, Han, Santillan & Schwille, 2008; Voss, Kunter & Baumert, 2011). Similarly, in Turkey, there is a scarcity of research that examines PK of pre service science teachers. When the studies avaible in Turkish literature considered, they mainly investigate pre service biology and chemistry teachers' PK by examining teacher education curriculum with respect to teaching profession courses (Kılınç & Salman, 2009) and investigate the results of Public Personnel Selection Examination (KPSS) according to the participants achievement level in teaching profession part of the exam (Yıldırım & Koca, 2015). Literature calls more research examining PK of pre service teachers in different subject areas (Choy, Lim, Chong, Wong, 2012; Voss, Kunter & Anders, 2010). Therefore, the results of the study are expected to provide significant information in terms of presenting Turkish pre service science teachers' perceptions belonging to PK. Their perceptions could provide feedback in determining in what areas of PK pre service science teachers feel that they have problems and findings could be used in revising the courses in science teacher education program. Moreover, as mentioned in the OECD report (2014), in terms of teacher knowledge, studies have generally been performed with a small number of participants. The current study was conducted with a larger sample and the findings of the study might be used for making generalizations in pre service science teachers' perceptions regarding PK.

In addition, PCK has been studied for more than twenty years and a majority of the studies are qualitative in nature but Abell (2008) suggested use of quantitative and mixed method. Studies mostly used lesson preparation methods, metaphors, observation and the most preferred instrument are interviews in the PCK field (Aydın & Boz, 2012). As Borowski, Carlson, Fischer, Gess-Newsome, Henze, Kirschner and van Driel (2012) point out large scale studies mostly found in mathematics education in PCK field while science education lacks large scale studies (Schmelzing, van Driel, Jüttner, Brandenbusch, Sandmann, & Neuhaus, 2013). In this study, quantitative research tradition is preferred via using questionnaires; therefore, the results of the study could make contributions to the gap in the existing literature in terms of studying PCK quantitatively. Moreover, there is a few study that examine

PK and PCK of pre service science teachers together in Turkish context (Aydın & Boz, 2012).

Additionally, the number of studies in the literature concentrating on perceptions with respect to PCK is limited. Identifying pre service teachers' perceptions has great importance in order to promote their learning since perceptions had influence on learning (Bukova-Güzel, Cantürk-Günhan, Kula, Özgür & Elçi, 2013); therefore, this study is hoped to contribute to the literature by presenting pre service science teachers' perceptions related to PCK.

In terms of research, the present study has some implications. Perceptions of Knowledge and Skills in Teaching (PKST) scale was translated into Turkish and validated with large sample in order to measure pre service teachers' perceptions pertinent to PK. Additionally, the instrument originally developed for investigating pre service mathematics teachers' perceptions regarding PCK was adapted for pre service science teachers. Hopefully, these two instruments can be used by researchers in future studies in PK and PCK field related to science education.

The study might also have some contributions to practice. Based on in what components of PK and PCK pre service science teachers perceive themselves as adequate or inadequate, elective courses could be offered in science education departments Moreover, depending upon their perceptions, courses given in the science teacher education programs would be revised. As Adam and Krockover indicated teacher education programs should make changes in order to make pre service teachers improve their PCK (1997).

1.4. Definitions of Terms

Pedagogical knowledge: "with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter" (Shulman, 1987, p. 8).

***Pedagogical content knowledge*:** "the knowledge that is developed by teachers to help others learn" (Shulman, 1986).

Lesson planning: refers to "planning and providing a set of learning opportunities that offers access to crucial concepts and skills for all students" (Choy, Wong, Lim & Chong, 2013, p.69).

Classroom management: "arranging of the environment for learning and maintaining and developing student-appropriate behavior and engagement in the content" (Rink, 2002, p. 136).

Assessment: refers to "knowledge of different forms and purposes of formative and summative assessments, knowledge of how different frames of reference (e.g., social, individual, criterion-based) impact students' motivation" (Guerriero, 2012, p. 6).

Knowledge of science learners: defined as "knowledge teachers must have about students in order help them develop specific scientific knowledge" (Magnusson et al, 1999, p. 104).

Knowledge of science curriculum: It involves two categories and they are defined as "teacher knowledge of the goals and objectives for students in the subject they are teaching" and "knowledge of the programs and materials that are relevant to teaching particular domain of science and specific topics within that domain (Magnusson et al, 1999, p. 103).

Knowledge of science assessment: It includes two categories. First category refers to "teachers' knowledge of the aspects of students' learning that are important to assess within a particular unit of study" (Magnusson et al, 1999, p. 108) and second category defined as "teachers' knowledge of the ways that might be employed to

assess the specific aspects of student learning that are important to particular unit of study" (Magnusson et al, 1999, p. 109).

Knowledge of science instructional strategies: defined as "subject-specific strategies are broadly applicable, they are specific to teaching science as opposed to other subjects and topic-specific strategies are much narrower in scope, they apply to teaching particular topics within a domain of science" (Magnusson et al, 1999, p. 110).

Orientation towards teaching science: "teachers' knowledge and beliefs about the purposes and goals for teaching science at a particular grade level" (Magnusson et al, 1999, p. 97).

Pre service science teachers: In this study it describes fourth grade pre service science teachers attending Department of Elementary Science Education of Faculties of Education.

CHAPTER II

LITERATURE REVIEW

In chapter, existing literature related with the present study is summarized. It includes mainly three parts. In the first part, elementary science education in Turkey is examined. In the second part, science teacher knowledge including pedagogical knowledge (PK), its components, pedagogical content knowledge (PCK) and its components are presented as the variables of the study in details. Lastly, studies related with PK and PCK both in Turkish and in international context are mentioned.

2.1. Elementary Science Education in Turkey

In the last twenty years, Higher Education Council (YÖK) made some changes in teacher education programs. In 1998, especially elementary education departments with the transition to eight year compulsory education gained importance. It was emphasized that programs like elementary science teaching, elementary mathematics teaching etc. should be opened in education faculties. In 2007, YÖK again revised the teacher education programs which are still being implemented in faculties of education today. The aim was not to change the 1997 program totally, but was rather to solve some of the problems and provide coherence between the teacher education programs and the changing programs of elementary and secondary schools. According to this revised program, number of courses related with general culture is increased and the new program provides pre service teachers the flexibility to some extent for choosing courses from the program as elective courses. The percentages of the courses in the revised program are: General cultural courses 15-20 %, teaching profession courses 25-30 %and content area courses 50-60%. (YÖK, 2007). Today, seventy universities which have elementary science teacher education programs in Turkey follow this program (ÖSYM, 2015).

The revised program of science teacher education program covers three major areas (see Appendix A) as indicated before (YÖK, 2007): content area courses, teaching profession courses and general culture courses. In terms of science education, some of the content area courses include physics, mathematics, evolution, organic chemistry etc. Teaching profession courses consist of classroom management, guidance, school experience, instructional technology and material design, history and nature of science, educational psychology etc. Lastly, with the revised program, general culture courses gained more importance. The present study focused on teaching profession courses and examined it under two categories. The first category is related with the specific science teaching courses like methods of teaching science, lab. applications in science education etc. which helps pre service science teachers' to develop mostly their PCK. The other category is related with the general pedagogy courses like classroom management, introduction to education and guidance etc and these courses mainly help to develop pre service science teachers' PK.

Meriç (2004) aimed to evaluate the science teacher education programs in the context of Turkey, Japan, America and England. Based on the comparison of Turkish science teacher education programs with others, some suggestions were made. It was suggested that science teacher education programs should provide pre service science teachers knowledge about integrating content, pedagogy and student understanding, practicing hours needed to be increased, cooperation between practicing school and teacher education departments should also needed to be increased to make the transition from pre service teachers to beginning teachers smoothly.

Moreover, in the same direction the study carried out by Temizsoylu (2010) compared science teacher education programs of Turkey and the United States and identified the similarities and differences between these programs. The researcher compared the education programs of Michigan and Ohio Universities science education programs with the Turkish science education program. Results of the study showed that there is not a standard science education programs in the United States, every state has its own program based on the NSTA (National Science Teacher

Association) standards. Moreover, entrance to the science education departments was also different from Turkey and it included written exam, grade point average, personality test etc. In this study, it was also emphasized that practicing hours in Turkey were less than the hours the United States.

2.2. Science Teacher Knowledge

Baumert and Kunter (2006, as cited in Riese, Vogelsang, Reinhold, 2012) indicated that professional knowledge of teachers includes content knowledge (CK), pedagogical knowledge (PK) and pedagogical content knowledge (PCK). In order to investigate pre service science teachers' perceptions regarding science teaching, a model suggested by Abell (2007) related to science teacher knowledge, which is based on Grossman (1990) and Magnuson, Krajcik and Borko (1999) models was used as a framework in the present study. The model is given in Figure 2.1.

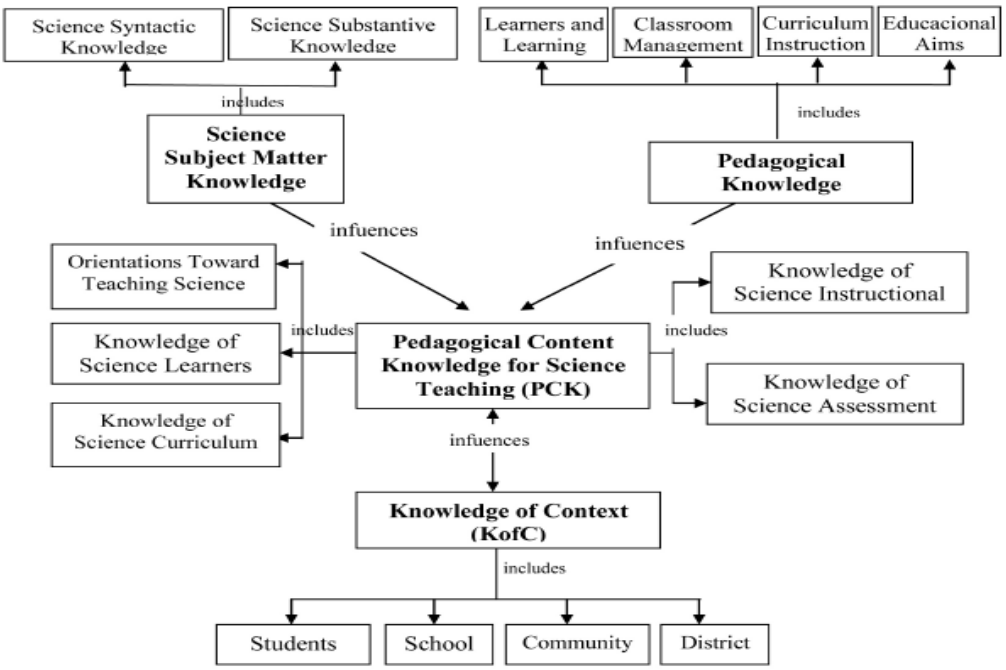

Figure 2.1 Abell's Model (2007) of Science Teacher Knowledge (p. 1107)

Major components of the model are described below.

2.2.1. Pedagogical Knowledge

Shulman defined general pedagogical knowledge (GPK) as "broad principles and strategies of classroom management and organization that appear to transcend subject matter" (1987, p. 8). In a similar way, Lederman and Gess-Newsome defines pedagogical knowledge (PK) as "teacher's knowledge of general pedagogy such as classroom management, questioning, planning, and so forth" (1992, p.16). According to Abell's Model (2007) knowledge of instructional principals, classroom management, learners and learning and educational aims are included in the category of PK. Moreover, Koehler, Mishra and Cain (2013) stated that PK concerns with knowledge about teaching and learning process; hence it contains lesson planning, classroom management, different instructional and assessment methods and individual properties of learners. Since teaching content without having GPK is not possible, teachers should understand and develop deep understanding of GPK.

Based on the Shulman's definition of GPK, Grossman (1990) made differentiation between PK and PCK by stating PK is separate from PCK and it is not subject matter specific, for example, it is not specific to science, mathematics or literature teaching. Similarly, Demirdöğen (2012) in her thesis pointed out that pedagogy consists of general teaching, assessment and reinforcement etc. and in any discipline PK could be implemented. It is crucial to make clear distinction between PK and PCK since the present study focus on both PK and PCK. Uşak (2005) indicated that PCK concerns with how subject matter make accessible for students rather than concerning the general principles of teaching and learning. Furthermore, Tamir (1988) distinguished PK and PCK in his study and stated that

> Firstly, there is a sharper distinction between general pedagogical knowledge and subject matter specific pedagogical knowledge. Each comprised of four categories, namely, student, curriculum, instruction and evaluation. This distinction is very important with regard to teacher education. Since, while the first (i.e. general pedagogy) may be handled by experts in general pedagogy and, hence, can be taught in mixed disciplinary classes, the second (i.e., subject matter specific pedagogical knowledge) must be handled by instructors who are pedagogical experts in a particular discipline working with student teachers preparing to teach in that discipline (p.100).

Tamir (1988) used the term subject matter specific knowledge instead of PCK. Further clarification of difference between PK and PCK is presented in Figure 2.2. According to Tamir (1988), although GPK and subject matter specific pedagogical knowledge have common components, every component covers different type of knowledge and skills.

General Pedagogical Know.	**Subject Matter Specific Pedagogical Know.**
1. Student	**1. Student**
1.1. Knowledge: Piaget's development levels	1.1. Knowledge: Specific common conceptions and misconceptions in a given topic
1.2. Skills: How to deal with hyperactive student	1.2. Skills: How to diagnose a student conceptual difficulty in a given topic
2. Curriculum	**2. Curriculum**
2.1. Knowledge: The nature, structure and rationale of Bloom's taxonomy	2.1. Knowledge: The pre-requisite concepts needed for understanding photosynthesis
2.2. Skills: How to prepare a learning unit	2.2. Skills: How to design an inquiry oriented laboratory lesson
3. Instruction	**3. Instruction**
3.1. Knowledge: Different ways of assigning turns to students in class discussion	3.1. Knowledge: A lab. Lesson consists of three phases
3.2. Skills: How to formulate a high level question	3.2. Skills: How to teach students to use a microscope
4. Evaluation	**4. Evaluation**
4.1. Knowledge: different types of tests	4.1. Knowledge: The nature and composition of the practical test assessment inventory
4.2. Skills: how to design a multiple choice item	4.2. Skills: How to evaluate manipulation laboratory skills

Figure 2.2 Difference between GPK and PCK (modified from Tamir, 1988, p. 100)

Morine-Dershimer and Kent (1999) conceptualize three major areas that contribute the development of PK (Figure 2.3): classroom management and organization, instructional models and strategies and classroom communication and discourse. In this figure, it can be seen that personal pedagogical knowledge interacting with the general pedagogical knowledge. Moreover, personal pedagogical knowledge is influenced by person's personal beliefs and perceptions and also personal practical experience. They explained classroom management as using time efficiently, applying instructional strategies and preventing problems in the classroom and having influence on student learning. Instructional model and strategies as another element contributing to GPK contains knowing about alternative ways of instruction and using these alternatives in an appropriate manner. When using different approaches, content and purpose of the topic should be considered and the most suitable instructional strategy should be chosen. Lastly, classroom discourse is a crucial component of GPK because by improving communication ways in the classroom, teacher could meet different needs of students. Furthermore, teacher should be aware of the impact of gender and cultural differences between students to encourage students' participation in classroom communication. As a result, these three components of GPK are interrelated to each other and GPK is supported by personal pedagogical knowledge as seen in Figure 2.3.

Morine-Dershimer and Kent (1999) also explained how personal pedagogical knowledge develops. Based on the Figure 2.3, personal beliefs/ perceptions and personal practical experience contribute to personal pedagogical knowledge and later have impact on PCK. They advocated that prior beliefs and perceptions influence personal pedagogical knowledge since pre service teachers already have their own beliefs about teaching before starting the university. Pre service teachers' beliefs and perceptions may change as they engage with the courses but their prior beliefs and perceptions have great influence on what they learn. As a second source, they presented personal practice experience which develops with real classroom experience.

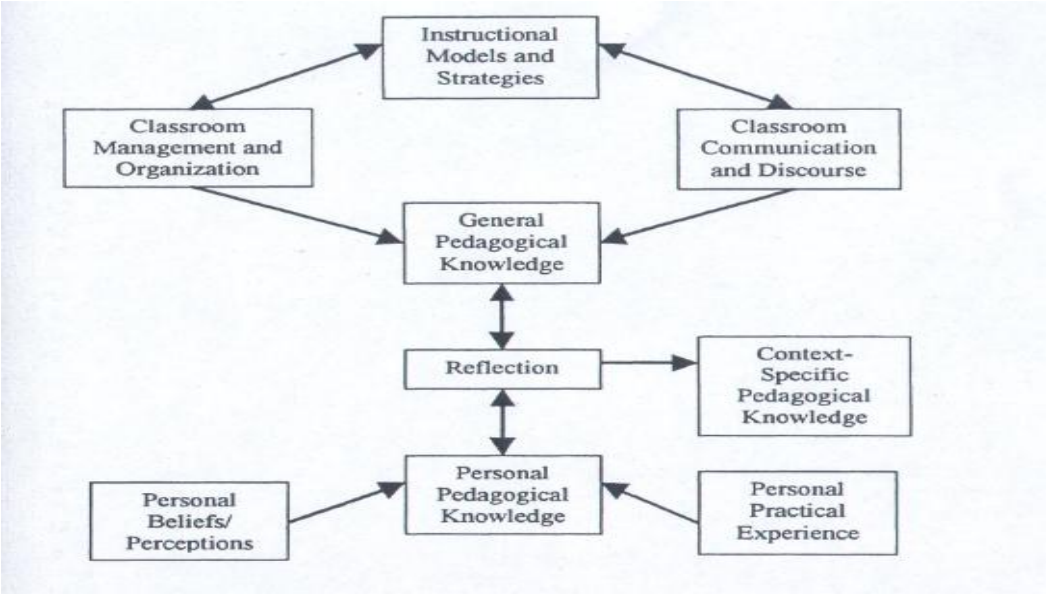

Figure 2.3 Morine-Dershimer & Kent's Model (1999) of Pedagogical Knowledge (p.23)

Hudson (2013) used the model in Figure 2.4 as a framework for observation of pedagogical practices of pre service teachers by their mentors in the classrooms. According to framework, pedagogical knowledge is comprised of planning, time tabling, preparation, teaching strategies, content knowledge, problem solving, classroom management, questioning skills, implementation, assessment and viewpoints. He believed that these strategies represent the pedagogical knowledge practices in classrooms.

Figure 2.4 Pedagogical Knowledge Components (Hudson, 2013, p.365)

In the present study, four components are covered under the category of GPK: learners and learning, classroom management, assessment and lesson planning which shows parallelism with Abell's model (2007) and studies related with GPK in the literature (König, Blömeke, Paine, Schmidt, Hesieh, 2011; Voss, Kunter, & Baumert, 2011).

The first component is classroom management which König and Kramer (2015) defined it as "the teacher's specific knowledge and skills related to the challenge of managing a classroom, belongs to the area of general pedagogical knowledge thus contributing to an essential component of professional teacher competence". According to another study conducted by König and Blömeke (2012) classroom management also includes teacher knowledge related with motivating students individually and in a group, prevent and eliminate problems and also prevent conflict in the classroom as well as using time in an effective way (Baumert et al, 2010). Classroom management is one of the fundamental factors in classrooms in order to learning takes place and is connected with pedagogical knowledge (Garrahy, Cothran & Kulinna, 2005). Within this direction among other components, classroom management is considered as essential component of GPK.

Secondly, planning is crucial component of instruction since it is a way of achieving the objectives of lesson and sometimes could be challenging for teachers (Saad, Chung, & Dawson, 2014). Lesson planning includes writing lesson plans and providing resources for students (Choy, Wong, Lim & Chong, 2013). Teachers need to plan and form an environment in the classroom that results in students' learning and lesson planning directs the action of a teacher in the classroom (Choy, Wong, Lim & Chong, 2013). Lesson planning provides beginning teachers what is required for teaching and prepare teachers to possible emerging problems when delivering instruction (Hayes, 2003). According to Hudson and Ginss (2007) PK involves planning for science teaching and it is considered as one of the components of PK in the present study. Moreover, in terms lesson planning remarkable amount of time is allocated in teacher education programs in order to develop skills on lesson planning (Derri, Papamitrou, Vernadakis, Koufou & Zetou, 2014).

The other component of PK is learning and learners. It covers the knowledge about using a diverse range of strategies in order to attract students' attention to the lesson and promote their thinking skills (Wong, Chong, Choy, & Lim, 2011). Borko and Putnam (1996, as cited in Harr, Eichler & Renkl, 2014, p. 2) described it as "knowledge and beliefs about learners, how they learn and how that learning can be fostered by teaching" (p.676). Having this type of knowledge is necessary for teachers in order to understand the learning process of students. In OECD report (2014), it was indicated that teachers should have not only content knowledge and classroom management knowledge, but also should have knowledge about learners and learning. In a similar way, Voss, Kunter and Baumert (2011) advocated that knowledge about learning process is a component of GPK since every student has different characteristic which could influence learning.

Moreover, in terms of assessment Voss, Kunter and Baumert, (2011) further stated that "knowledge of classroom assessment is crucial in enabling teachers to judge students' progress toward their goals and in helping them to adapt their instruction to the individual needs of their students". They also mentioned that assessment is a way for understanding whether objectives of lesson are achieved or not. Furthermore, assessment was also regarded as a component of GPK in the framework of the Teacher Education and Development Study in Mathematics Study to present pre service mathematics' GPK (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008).

2.2.2. Pedagogical Content Knowledge

The notion of pedagogical content knowledge (PCK) was firstly put forward by Shulman (1986) he defined it "special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (1987, p. 8) and as "the ways of representing and formulating a subject that make it comprehensible to others" (p. 9). Shulman (1987) noted that PCK is the combination of content and pedagogy in order to make the topic or problem accessible to the different interest and abilities of learners. He believed that teacher education programs should combine these two kinds of knowledge. PCK

helps teachers to make use of their content knowledge for instruction. Teachers use their pedagogical content knowledge to select the most appropriate instructional strategies for better understanding of students. In the same way, Saeli, Perrenet, Jochems and Zwaneveld (2011) asserted that it could be considered as special combination of CK and PK that develops with the practice.

In 1986, Shulman categorized teacher knowledge into three categories as follows: 1. Content knowledge, 2. Pedagogical content knowledge and 3.Curricular knowledge. Knowledge of content was described as "the amount and organization of knowledge per se in the mind of the teacher" (p. 6). Moreover, he stated that curricular knowledge includes a variety of programs to teach the subject for the students who were in different grade levels and knowledge of materials related to the program.

In the following year, Shulman (1987) divided teacher knowledge in 7 categories, namely, 1. content knowledge, 2. general pedagogical knowledge, 3. knowledge of the curriculum, 4. pedagogical content knowledge, 5. knowledge of learners and their characteristics, 6. knowledge of educational contents, 7. knowledge of educational aims, goals, values, and philosophical and historical foundations and emphasized importance of pedagogical content knowledge in his work and by asserting

> It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction. Pedagogical content knowledge is the category most likely to distinguish the understanding of the content specialist from that of the pedagogue (p.8).

There are many models of PCK and Gess-Newsome (1999) classified these models into two groups as seen in Figure 2.5: *integrative* and *transformativ*e models. In integrative model, there are three knowledge domains and PCK is in the intersection point of SMK, PK and contextual knowledge. Teachers should integrate these three domains while teaching. In this model, teacher may not realize the significance of integration of knowledge. On the other hand, transformative model put emphasis on the synthesized knowledge and PCK is the synthesis of subject matter knowledge, pedagogical knowledge and contextual knowledge. These knowledge bases are transformed into PCK by forming a new knowledge base and PCK has an impact on

teaching practice. Gess-Newsome (1999) stated that PCK is the only knowledge that makes students understands the specific concept.

In order to make the difference between the two models clear, an analogy is used (Gess-Newsome, 1999). According to the analogy, the integrative model is considered as a mixture from chemistry because mixtures are made up of two or more materials where identities of the materials are retained. It is physical combination and no new substance is formed. Contrarily, according to transformative model, PCK is the combination of subject matter knowledge, pedagogical knowledge and contextual knowledge and it is not accepted as a separate knowledge base. Compound is formed when two or more elements are chemically combined and new substances are formed. This new substance does not show the properties of elements that it was composed of. Likewise, PCK is formed by combination of SMK, PK and contextual knowledge and it is new type of knowledge.

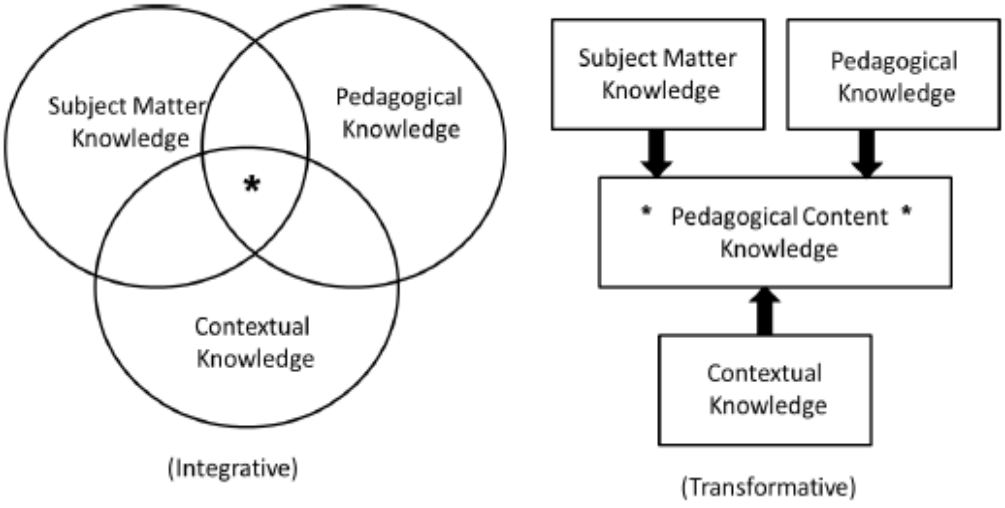

Figure 2.5 Gess-Newsome PCK Models (1999, p.12)

The other scholars also started to focus on PCK after 1986 and improved Shulman's work and presented new categories based on his studies. In 1988, Tamir was influenced by Shulman's framework of PCK and introduced six categories for teacher knowledge in his model. These categories were: general liberal education,

personal performance, subject matter, general pedagogical, foundations of the teaching profession and subject matter specific pedagogical knowledge. Tamir (1988) used the term subject matter specific pedagogical knowledge instead of PCK as indicated before. In his model subject matter specific knowledge included student knowledge, curriculum knowledge, instruction and evaluation. Tamir (1988) formed his model by adding knowledge of assessment as a component of PCK which was missing in the Shulman's model (1987). He also made a distinction between PK and subject matter specific pedagogical knowledge which was given in details in the previous section.

The other scholar, Grossman (1990), identified four main categories for teacher knowledge which were general PK, SMK, PCK and knowledge of context and schematized it as seen in Figure 2.6.

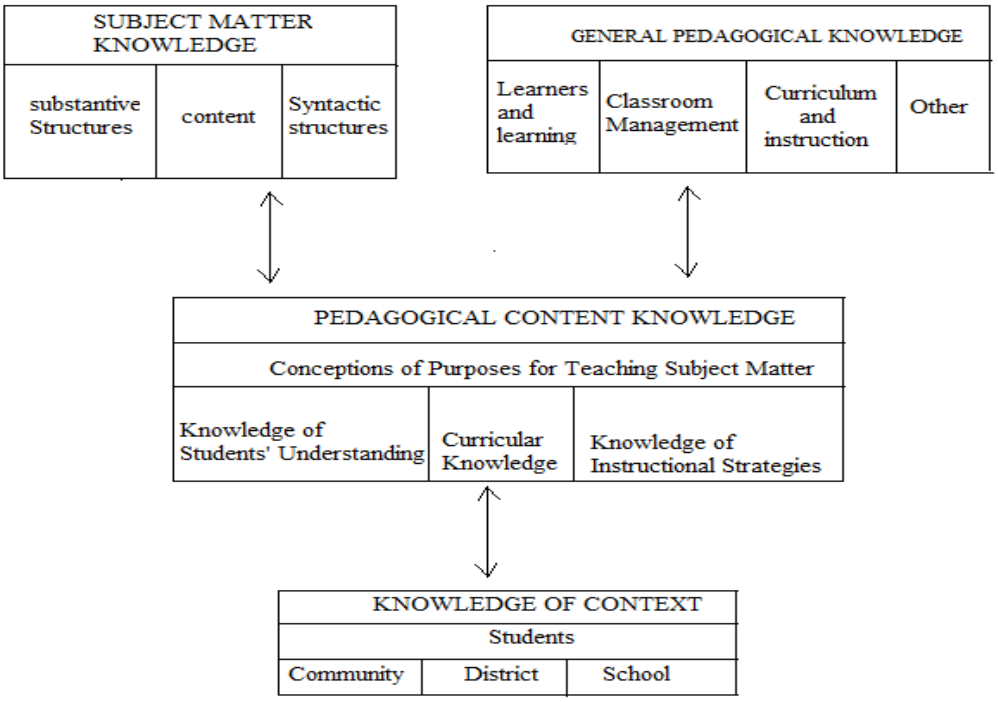

Figure 2.6 Teacher Knowledge Model (Grossman, 1990, p. 5)

In her model, Grosman (1990) added conceptions of purposes for science teaching subject matter as a subcomponent and it was an *overarching* component. When compared with the Tamir's model (1988) in terms of PCK, knowledge of assessment does not take place as component of PCK in this model. She also indicated that the division between the components in theory and in practice is not clear.

Cochran, King and DeRuiter (1991), proposed a PCK model based on constructivist view of teaching including 4 components: knowledge of curriculum, knowledge of educational goals and purposes, and knowledge of the content and pedagogical content knowing (PCKg). Different from the previous scholars, they used the term PCKg. In the model arrows showed the transition from novice to experienced teachers. They stated that these categories could be thought as separated and PCK was formed by integrating these components. As another difference, the knowledge of student was proposed as fourth component; not included in the PCK components which were different from the Grossman model (1990).

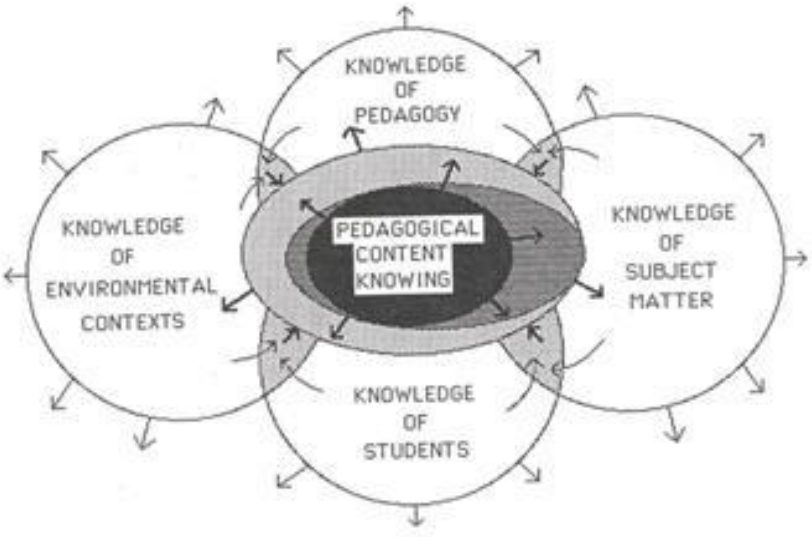

*Figure 2.*7 Cochran, King & DeRuiter (1993) PCK Model

The other model of teacher knowledge proposed by Carlsen (1990) included five components as seen in Figure 2.8: general pedagogical knowledge, subject matter knowledge, pedagogical content knowledge, knowledge about the specific context and knowledge about general education context. This model put more emphasis on

educational and specific context which is given in detail in the following section and divided pedagogical content knowledge into four sub categories. Although these sub categories show similarity with Grossman model (1990), Carlsen did not place purposes for teaching science as an overarching component.

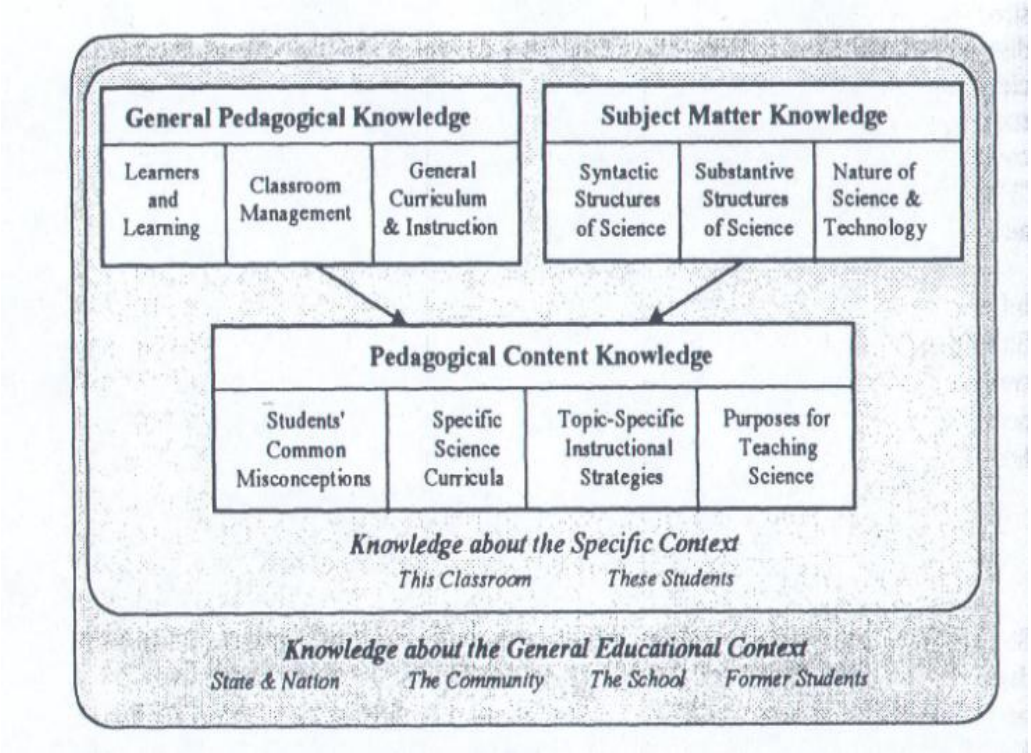

Figure 2.8 Carlsen (1990) PCK Model

Furthermore, Magnusson, Krajcik and Borko (1999) presented a new model including four different types of teacher knowledge: SMK, PK, PCK and knowledge about the context. In this model PCK has 5 components: orientations towards teaching science, knowledge and beliefs about the science curriculum, knowledge and beliefs about students' understanding of specific science topics, knowledge and beliefs about assessment in science, and knowledge and beliefs about instructional strategies for teaching science as provided in Figure 2.9. These are separate components but interacting with each other in order to contribute the development of PCK of teachers.

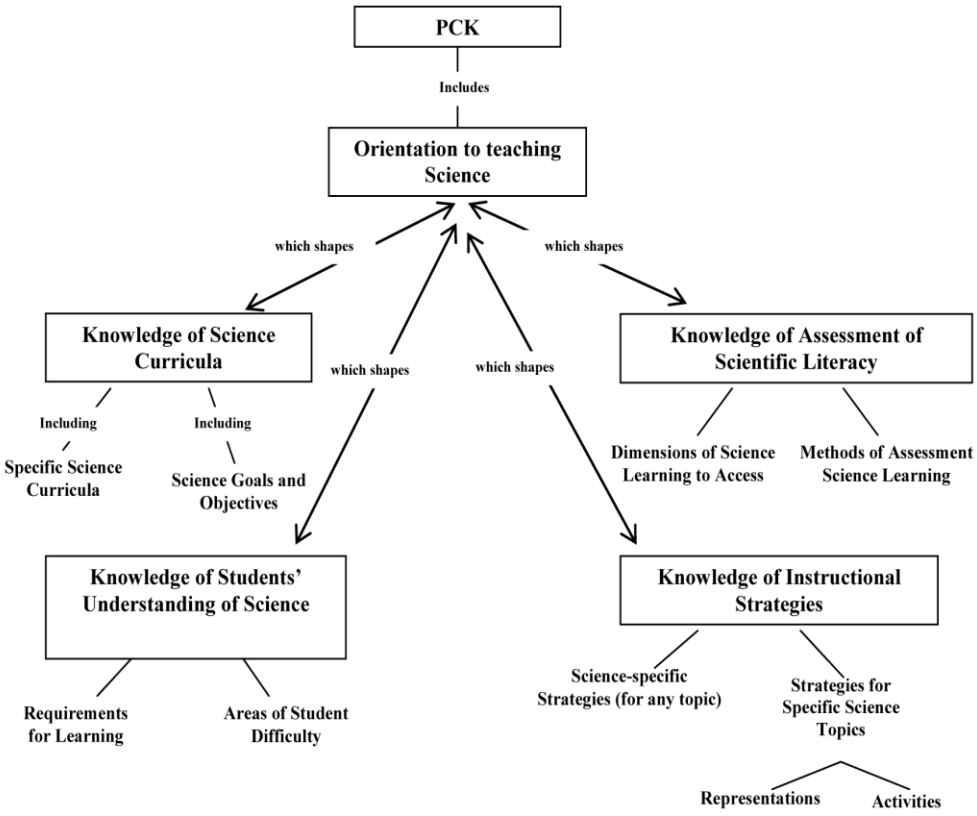

Figure 2.9 Magnusson, Krajcik & Borko (1999) PCK Model

In their model, Magnusson, Krajcik and Borko (1999) put knowledge of assessment of scientific literacy as a component of PCK which was similar with Tamir's PCK model. The other difference of the model was adding "orientation to teaching science" component which was earlier named as conceptions of purposes for teaching subject matter by Grossman. Similar to Grossman' model (1990) orientation towards science teaching component is the overarching component in this model.

Another science teacher knowledge model was introduced by Abell (2007) knowledge which includes four categories: Pedagogical content knowledge for science teaching (PCK), pedagogical knowledge (PK), science subject matter knowledge (SMK) and knowledge of context (KofC) as seen in Figure 2.1. Compared to Shulman's work (1986, 1987), components in this model are presented in more detail.

The first component is knowledge of science instructional strategies including two categories: knowledge of subject specific strategies and knowledge of topic specific strategies Subject specific strategies are related to teaching science while topic specific strategies are related with teaching one topic in science ; so subject specific strategies are more general (Magnusson, Borko, & Krajcik, 1999). Knowledge of subject specific strategies includes knowledge for general approaches for teaching science such as learning cycle, guided inquiry, conceptual change, using lab. etc. Teachers should be able to use different instructional strategies properly while teaching science. Moreover, this type of knowledge is partly related with orientations to teaching science component since goal of particular orientation show parallelism with general approaches of science instruction. Knowledge of topic specific strategies also have two sub categories: topic specific representations and activities can be seen in Figure 2.9. Models or analogies could be used in order to make topic accessible to learners. The other sub category is related to the knowledge of activities to help student understand specific concepts or relationships such as laboratories, drama etc.

Teachers who had strong knowledge of science teaching strategies knows how to and when to use appropriate strategies in order to make the content understandable for students while teaching. It is affected and supported by GPK (Peng, 2013). Pre service teachers' perceptions towards instructional strategies are important because pre service teachers have limited field experiences and may not be able to adopt new instructional strategies and approaches due to their unfamiliarity of this type of knowledge (Abell, Appleton & Hanuscin, 2010).

The second component is orientation towards science teaching. When Shulman firstly introduced the notion of PCK in 1987, orientation towards science teaching was not included as a component of PCK. However, in later studies based on Shulman's work, orientation component was included as a crucial component of PCK with different labels (Grossman, 1990; Magnusson et al., 1999). According to Magnusson, Krajcik and Borko (1999) it is "teachers' knowledge and beliefs about the purposes and goals for teaching a subject at a particular grade level" (p. 97)**.** This

component has an influence on the other components of PCK. As Borko and Putnam (1996, as cited in Magnusson, Krajcik & Borko 1999) emphasized orientation towards science teaching component directs instructional, assessment, and planning decisions.

Magnusson, Krajcik and Borko (1999) organized science teaching orientations as process, academic rigor, didactic, conceptual change, activity-driven, discovery, project based science, inquiry and guided inquiry. Teacher with different orientations may differ in their decision making, planning and implementing of teaching (Magnusson, Krajcik & Borko, 1999). For example, the teacher who adopts a discovery change may use different instructional strategies, activities and assessment than the teacher adopting academic rigor orientation.

However, Friedrichsen, van Driel and Abell (2011) criticized mainly two things about orientation to teaching science component. The first issue is use of different definitions for orientations by different researchers. For example, Grossman (1990) preferred to define it as purposes for science teaching while Magnusson (1999) defined it as general views about teaching science. The second issue is related with the nine different science teaching orientations that involved in Magnusson et al. model. These orientations come from different sources and it was indicated that they have deficient empirical base. Therefore, it was suggested to study science teaching orientations from different perspectives instead of trying to categorize teachers' orientation into nine categories in Magnusson, Krajcik and Borko's (1999) study. Orientation towards teaching science component was not the focus of the present study.

Moreover, third component which is knowledge of science curriculum, divided into two categories: Knowledge of goals and objectives and knowledge of specific curricular programs. Curriculum knowledge was considered as a domain for teacher knowledge in Shulman's work (1987) but later Grossman (1990) (Figure 2.6) included it as a component of PCK. This component provides teachers to develop understanding about the connection between topics and curriculum in a holistic view and teacher can make judgment about what should be included to achieve goals and

arrange activities (Park & Oliver, 2008). The first category is related to teachers' knowledge of goals and objectives. Grossman (1990) also stated that this category includes knowledge about vertical curriculum, i.e., what is learned from previous year and what is expected to learn from the following years. The second one consists of knowledge related with materials used while teaching science and the program in particular science topic. It includes teachers' familiarity with the curriculum materials.

Knowledge of science assessment component includes two categories: knowledge of dimensions of science learning to access and knowledge of method of assessment and it was firstly introduced by Tamir (1988). Knowledge of dimensions of science learning to access is related with what to assess in student learning while teaching science. The second one concerns with assessment knowledge of teachers' including instruments, procedures, approaches and activities. Teachers' knowledge of methods of assessment and choosing the most appropriate one for assessing students' performance in a particular unit are examined under this category of PCK. In addition, teachers need to know what advantages and disadvantages an assessment technique or device have while assessing particular aspect of learning. Abell (2007) pointed out, there is a connection between teachers' science teaching orientations and how teachers design and implement assessment in their classrooms.

The last component of PCK is knowledge of students' understanding of science and Magnusson et al (1990) defined this component teacher knowledge about how to increase scientific knowledge of students. There are two categories under this component: Knowledge of requirements for learning and knowledge of areas of student difficulty. Former one includes teacher knowledge and beliefs related with what students already know about specific science topics and understanding the different approaches held by students to learning. Teachers should know what skills and abilities students need while learning science concepts. The latter one implies to teacher knowledge about students' difficulty areas in learning specific science concepts and topics. Teachers should know in which topics students have difficulty for example abstract concepts and in which part is challenging for students. In the

present study, this component of PCK was investigated under two categories: Knowledge of learner and knowledge of misconceptions.

Abell (2007) concluded his study by suggesting there is still ongoing debate about the components of science teachers' PCK and instead of introducing new models, explicit conceptual framework is needed. Moreover, studies' focusing on how SMK is transformed into PCK and how these knowledge categories an influence learning of students is required.

Another model proposed by Park and Oliver (2008) is a hexagonal model consisting of six components. According to this model, PCK is at the center which makes it different from the Magnusson, Krajcik and Borko (1999) model. They also added teacher efficacy as a sixth component of PCK as seen in Figure 2.10. According to results of their research, by putting PCK at the center they indicated that PCK can be developed from any of the other components. In this model, development of one component could affect development of other components; therefore, improving one component could have influence on overall PCK. However, in order to enhance individual's PCK there is a need for coherence among components and developing one component of PCK may not result in changing individual's PCK in practice. Teacher efficacy was considered as component in this study because in order to determine problems and to choose appropriate teaching strategies to resolve the problems, teacher efficacy was regarded as having an essential role and emerged as a new component.

Additionally, PCK was categorized into two dimensions in this study: teachers' understanding and enactment. According to Park and Oliver (2008) "the concept of PCK not only represents teachers' understanding of how to teach subject matter effectively, but also the enactment of their understanding" (p. 280). Teacher efficacy also has a crucial role in connecting these two dimensions.

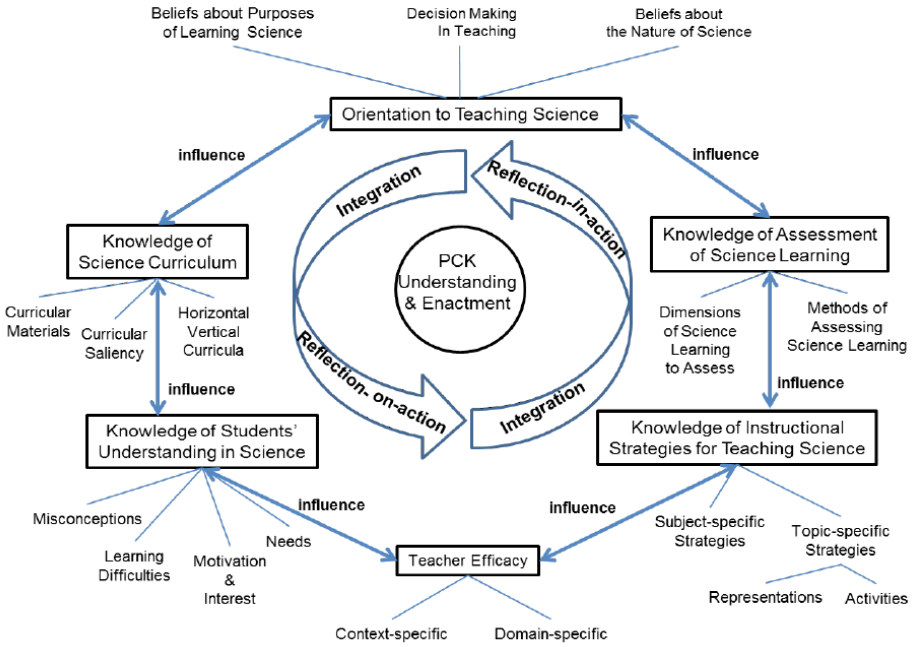

Figure 2.10 Park & Oliver's Model (2008) PCK Model (p. 279)

In conclusion, Aydın and Boz, (2012) suggested that there is need for further research in terms of how components of PCK interact with each other, how different components are used at the same time by the teachers and the nature of relationship between components. Moreover, Abell (2008) pointed out that there are still some questions that need to be answered in PCK research although PCK has been studied for twenty years.

2.2.3. Science Subject Matter Knowledge (SMK)

Although (SMK) is not the focus of the present study, as Magnusson, Krajcik & Borko (1999) emphasized in order to improve PCK, it is necessary for teachers to have essential amount of SMK. Lederman and Gess-Newsome (1992) defined subject matter knowledge as "teacher's depth and breadth of understanding and conceptualizations of his or her certification area (e.g. Biology for a biology teacher)" (p.16). Shulman (1987) used the term content in his categorization, but Tamir (1988) prefer to use subject matter knowledge. It includes substantive and syntactic knowledge. Schwab (1964, as cited in Tamir, 1988) made distinction

between substantive and syntactic structure of SMK. The first one is related to theories, models, facts and concepts whereas the second one is related to knowledge of methods, rules of evidence and ways of constructing knowledge relevant with the discipline. These structures are essential because the knowledge level acquired by teachers in terms of syntactic and substantive structure is mostly related with what teachers teach in the classroom (Tekin-Sitrava, 2014).

2.2.4. Knowledge of Context

The last category of teacher knowledge as presented in Figure 2.1 is knowledge of context. The present study did not aim to examine this category of teacher knowledge but it is important to examine this category for understanding of the teacher knowledge framework. It is comprised of students, school, community and district. Carlsen (1999) discussed the importance of context especially for the beginning teachers. He stated that context may affect teachers PCK and result in formation of new PCK for example, as time passes in teaching profession, teachers' understanding students' ideas may change and teacher may approach the student differently and this situation may both influence the PCK and PK of teacher. He further stated that classroom is affected by local changes and may affect teachers' understanding and beliefs. Zembal-Soul, Starr and Krajik (1999) stated that because of pre service teachers' lack of classroom experience, they mostly challenge with classroom management and may ignore the importance of context in their initial years.

2.3. PK and PCK Studies in Turkish and in International Context

2.3.1. Studies Related to PK

In this part studies related with pedagogical knowledge (PK) is summarized. Because PK is generic knowledge, studies including other subject areas that studied PK are also presented. As Abell (2007) stated that research on PK of teachers is very rare. One of the studies in this area was conducted in the context of Teacher Education and Development Study-Mathematics (TEDS-M). It is an international study including 17 countries and make comparisons between these countries in terms of

teacher education. The focus area of the study was mathematical content knowledge and mathematical pedagogical content knowledge. However, Germany, the USA and Taiwan focused on GPK of pre service elementary, middle and in service mathematics teachers. GPK was examined under four dimensions in this study: structure, motivation/classroom management, assessment and additivity. Results revealed that pre service mathematics teachers in German had higher scores on GPK test than U.S. pre service mathematics teachers. Moreover, pre service mathematic teachers who had more experience in practice schools in German and the USA performed better than ones who had less experience in teaching in GPK.

In their study, Wong, Chong, Choy and Lim (2012) focused on pedagogical knowledge and skills of student teachers in the context of Post Graduate Diploma in Education program which included four different parts: education studies, curriculum studies, academic discourse skills and practicum. They studied with 812 participants and "Pedagogical Knowledge and Skills" (PKST) survey that includes six factors was applied to participants in three different times: before starting the post graduate program, at the end of the program and after one year they graduated from the program. They concluded that before starting the program pre service teachers' assessed themselves as having pedagogical knowledge and skills because they had some experiences as a student teacher. Results of MANOVA indicated that between entering the program and after one year of teaching there was a significant increase in participants' level of pedagogical knowledge and skills in all factors of PK.

Another similar study was conducted in Singapore context (Wong, Lim & Chong, 2013) as a longitudinal study. It lasted three years and aimed to investigate beginning teachers' perceptions of their pedagogical knowledge and skills under three dimensions, lesson planning, instructional strategies and classroom management. Data were collected from participants after they graduate the program, after one year and three years they started to teach from 358 participants. For data collection, three factors of "Pedagogical Knowledge and Skills" (PKST) survey was used. According to the results, between the graduation and after one year of teaching, perceptions of knowledge in terms of classroom management significantly increased while in terms

of lesson planning and instructional strategies their perceptions still the same. However, after three years of teaching, in all factors of PK, participants' perceptions level significantly increased. The reason for why participants' perceptions did not change significantly in two dimensions in their first year was explained by teachers tried to accommodate themselves to school climate in their first year and could not totally concentrate on improving their knowledge. However, after adaptation to the school climate, they had a chance to develop their PK.

The other study carried out by Voss, Kunter and Baumert in 2011. They used the term 'general pedagogical/psychological knowledge' (PPK) based on Shulman's idea (1987). PPK has five dimensions including knowledge related to classroom management, teaching methods, assessment, learning process and individual students' characteristics. Knowledge of teaching methods was considered as pedagogical knowledge whereas classroom management and assessment belonged to psychological knowledge. On the other hand, learning process and individual students' characteristics dimensions were considered as suitable for both pedagogical and psychological dimensions. The study firstly focused on developing PPK instrument comprised of 39 items including multiple choice, short answer and video-based items. Later, the instrument was administered to 746 pre service secondary mathematics teachers in German. There were two phases in teacher education program in German. The first based on theoretical courses and the second phase based on practice. Sample consisted of pre service teachers that do not have any experience in teaching and that newly began to teaching in the second phase. Results indicated that mean scores of pre service teachers that had experience was higher than the group with no teaching experience in relation to classroom management. There was no statistical difference for the other sub-dimensions when two groups were compared. Moreover, PPK and mathematics knowledge were not correlated to each other. They concluded that instrument was valid and reliable and suggested that further research is needed with pre service and in service teachers with the samples from other subject areas and from different countries.

Blömeke, Paine, Houang, Hsieh, Schmidt, Tatto, Bankov, Cedilllo, Cogan, Han, Santillan and Schwille (2008) studied with 2628 pre service mathematics teachers from six different countries in the context of Mathematics Teaching in the 21st Century (MT21). One of the aspects that participants tested was GPK. The open-ended instrument was developed for the study and GPK measured in three sub-dimensions: lesson planning, assessment and socio-economic differences. Results of four countries (Germany, the US, Korea and Taiwan) were reported in this study. It was concluded that there were differences in participants' level of GPK between these countries in relation to GPK due to the cultural differences.

Different from the other studies, Hudson (2004) focused on perceptions of fourth grade primary pre service science teachers related to PK of their mentoring teachers in Australian context. As data collection tool a survey which was associated with course outcomes was used and administered to 383 participants. Results showed that generally pre service teachers perceived their mentors level of PK low in primary science teaching. Therefore, it was concluded that in order to improve and guide pre service teachers' PK, mentors need to create professional development opportunities for effective mentoring. Furthermore, Hudson and Ginn (2007) studied with second year pre service elementary science teachers in the context of science curriculum and methods course. Purpose of the study was to assess participants' perceptions related to science teaching and their pedagogical development before and after the course. Data were gathered from 59 participants and survey including 37 items was developed based on the course outcomes. It was administered to participants as pre-test and post-test. The survey included four constructs as follows: theory, children's development, planning and implementation. Results indicated that there was a significant increase in mean scores of participants before the course and after the course and the highest difference was in planning dimension. As a result, pre service science teachers perceived that their pedagogical knowledge had improved in these dimensions.

Okanlawon (2014) studied with pre science teachers in order to elicit their competency in terms of PK after practicing course in Nigeria. 210 participants were

involved in the study. Instrument named "Perceptions of the Acquired Pedagogical Knowledge and Skill Scale" (PAPS) consisting 56 questions were implemented. Teaching competencies were examined under 8 themes: planning instruction, implementing instruction, reinforcing learning, evaluating instruction, managing classroom, understanding learners' development, professional link with colleagues and integrating technology and media in classroom. It was concluded that planning, evaluating, implementing the instruction and integrating technology and media were the most problematic themes and participants did not feel themselves competent in these themes.

There are few studies directly focused on PK of pre service and in service teachers in Turkey. One of the studies was conducted by Oskay, Erdem and Yılmaz (2009) with 99 pre service chemistry teachers. The study aimed to investigate the relationship between participants' beliefs and their pedagogical knowledge. For data collection "Beliefs about Teaching Scale" and multiple choice test were used. Multiple choice test covered of 30 items that consists selection of KPSS exam questions from previous years related with classroom management, assessment and methods of teaching. Findings indicated that most of the participants were agreed on using inquiry, demonstration, discovery and problem based learning while teaching. In terms of assessment, majority of the participants reported that they agreed that they can use different types of assessment techniques such as summative and formative test, projects, essay test etc. In relation to classroom management, most of the participants believed that they could manage group work, classroom discipline, learner differences while there were problems in managing learners who experiencing focusing problems, gifted and disabled students. According to the results of the study, relationship between pre service chemistry teachers' beliefs and pedagogical knowledge was non-significant. Moreover, in terms of gender, participants' beliefs were also non-significant.

The other study was conducted by Savaş in 2011 and aimed to explore pre service science teachers' perceptions regarding technological pedagogical content knowledge (TPACK) in the topic of genetics by using TPACK framework. Although

the main focus of the study was not directly investigating PK, since it was one of the components of TPACK, the results of the PK component was examined. 1530 pre service science teachers with different grade levels were surveyed and results indicated that among other components of TPACK, participants' perceived PK mean value was the highest. In terms of gender, female participants' perceived PK level was higher than the male participants' perceptions with small effect size. Moreover, related to PCK, significant mean difference according to gender was found which was slightly small. Since PK was not science specific knowledge, studies conducted with different samples also examined. In a similar way, another study that used TPACK framework aimed to examine the relationship between TPACK and achievement level (Erdoğan & Şahin, 2010). 137 elementary and secondary mathematics teachers were included in the study and survey of TPACK was preferred for data collection. When the results related to PK was examined, it was found that male and female participants' scores were not significantly different from each other. Moreover, Bulut (2012) investigated pre service mathematics teachers perceptions related to TPACK in the topic of geometry. 780 participants who were in the third and fourth grade were included in the study. When components of TPACK examined, it was found that participants feel themselves competent in terms of PK. In relation to gender, mean scores of female participants was higher than male participants.

2.3.2. Studies Related to PCK

In this part, studies related to pre service and in service teachers' PCK is given. While presenting the related studies, two criteria were considered. Firstly, studies concentrating on science topics were included and studies related with math, language or etc was not selected. Secondly, studies that focused more than one components of PCK were chosen.

Van der Valk and Broekman (1999) aimed to investigate how pre service teachers' reflect their PCK in their lesson plans. Pre service science and mathematics teachers were the participants of the study. Lesson preparation method was utilized and for pre service science teachers, temperature and heat topic was selected. They used

Magnusson et al. (1999) PCK model although it was not indicated evidently in the study. Participants were given a topic and then prepared a lesson plan. After preparing lesson plans, they were interviewed. As a result, in participants' lesson plans, all of the components of PCK were seen clearly and lesson plan provided a chance to enhance participants' PCK.

Deborah, Hanuscin, Michele and Akerson (2010) conducted a study with three elementary science teachers by using Magnusson, Krajcik and Borko (1999) PCK model. The purpose of the study was to examine teachers' PCK for teaching nature of science (NOS). Data were gathered from interviews, observations, artifacts and questionnaire during three years. Results showed that teachers did not use their curriculum knowledge when teaching NOS. They had necessary knowledge of instructional strategies but in terms of knowledge of assessment, especially for topic specific assessment techniques, their knowledge was inadequate.

Goodnough (2006) developed a problem based learning (PBL) curriculum as a part of the teaching methods of science education course and aimed to investigate how PBL approach changed participants' knowledge and practice experiences. 28 pre service science teachers took the course and involved in the study. Data collections tools were field notes, students' plans and interviews. Result related with the PCK indicated that PBL based course had positive effect on development of components of PCK.

Another study focused on the beginning teachers' PCK in (Lee, Brown, Luft & Roehrig, 2007). 24 secondary science teachers who were newly began to teaching and attend induction program included in the study and two components of PCK, knowledge of student learning and knowledge of instructional strategies, were investigated. Teachers were classified into four groups as e-mentoring, general, intern and science-specific. Interview and classroom observations were used in order to collect data and administered at the beginning of the semester and at the end of the semester. It was found that beginning teachers' PCK was not adequate. There was no significant difference between teacher groups in terms of two components of PCK. However, when the all teachers participated in the study considered without

grouping, there was a significant increase regarding knowledge of student component. It was suggested that understanding of how beginning teachers improve their PCK was useful for pre service teacher education programs and for induction programs.

Koh, Chai and Tsai (2010) studied with 1185 pre service primary and secondary science teachers in order to explore their TPACK. Moreover, effect of some of the demographic variables on TPACK such as age and gender were examined. Survey including 29 items was administered to the participants. Results of EFA showed that there were five components of TPACK although Mishra and Koehler (2006) introduced seven components. They indicated that participants were unable to make distinction between PK and PCK due to lack of experience. These two factors were involved together as a one factor and named as knowledge of pedagogy. In terms of knowledge of pedagogy, findings of the study suggested that participants' perceptions were high. Moreover, the relationship between the components of TPACK and age was weak.

Halim, Mohd and Meerah (2002) investigated science teachers' PCK by focusing two components with 12 participants in physics field. Two components of PCK were knowledge of students' understanding and knowledge of strategies teaching particular topics. Participants were selected from a post-graduate program voluntarily. Some participants did not have any teaching experience while some of them had limited experience. Survey design was utilized and later some of the participants were selected to be interviewed to get deeper understanding of their PCK. Based on the findings, it was indicated that there were problems in participants' SMK. Because of their limited knowledge in SMK, most of the participants also had inadequate knowledge of detecting students' misconceptions. Moreover, while some teachers use different ways to present topic comprehensible to students, some of them did ignore the misconceptions and use their existing instructional strategy. In conclusion, researchers emphasized the importance of developing SMK and practicing experiences were needed to make progress in PCK.

Another study carried out by Donnely and Hume (2015) used collaborative technology (wiki) and examined the effect of using wiki on pre service teachers' improvement of PCK in the methods of teaching chemistry course context. Seven participants were involved in the study and case study design was used. Data were collected from CoRe artefact, reflections and semi-structured interviews. Magnusson, Krajcik and Borko (1999) model of PCK was used to assess participants' development of PCK. Results indicated that using technology had influence on CoRe design and hence contributed to the improvement of participants' PCK. When the results related with each component examined, it was seen that participants realized that they had inadequate knowledge in terms of student learning and misconceptions. However, they were able to use variety of method for instruction and assessment due to the nature of topic taught. It was emphasized that observation was required in order to elicit pre service science teachers' PCK.

In the last decades the number of studies in the PCK field increased in Turkey (Aydın & Boz, 2012). One of the studies was conducted by Tuzcu (2011) and examined the pre service science teachers' PCK by using Magnusson, Krajcik and Borko (1999) model. Qualitative research tradition was utilized and data were collected from three participants through observations, semi structured interviews and lesson plans. Participants were the 4th grade pre service science teachers. Results indicated that pre service science teachers' PCK were limited and participants had difficulty in reflecting what they had learned from the courses into the real classroom situations. When the results for each component examined in detail, regarding assessment, except from one participants, others reported that they had knowledge about different assessment methods but they did not know how to and when to apply these methods. Related with knowledge of curriculum, participants prepared lesson plans in accordance with the objectives but they had problems in purposes of science curriculum and including all the students in the classroom activities due to their lack of experience. Moreover, participants had knowledge about students' prior knowledge and characteristics of students but in practice they could not be able to apply their knowledge because of lack of experience. Lastly, although in interviews participants stated that using analogies, presentations, questioning were very

important in science lessons and teachers had to choose the most suitable strategies in a given topic, they preferred teacher centered approaches in their teaching. It was suggested that practice time in schools need to be increased and educators of pre service teachers' PCK should also be examined.

Other study was carried out by Aydın (2012) in order to examine in-service chemistry teachers' PCK in electrochemistry and radioactivity topics. Two teachers having eight and fifteen years of experiences were involved in the study and qualitative method was utilized. Different from the other studies in Turkey as data collection tool card sorting activity, content representation (CoRe), observations and semi structured interviews were used. Results suggested that PCK of teachers were different in two chemistry topics and this may due to the nature of the topic they taught. Moreover, teachers had quite knowledge in terms of knowledge of assessment and knowledge of learners and misconceptions in electrochemistry than radioactivity topic.

Uşak (2005) studied PCK and SMK of pre service science teachers in terms of flowering plants. Case study was utilized and four participants were included in the study. Videotapes, concept maps, lesson plans, documents and interviews were the data collection tools for this study. Results indicated that there was no significant relationship between SMK and PCK of pre service teachers. Regarding SMK, participants had some misconceptions in the selected topic and had difficulties in understanding related science concepts. For knowledge of assessment component, they preferred to use traditional techniques mainly multiple choice test and open ended questions. Implementation of knowledge of learner dimension was also problematic in practice although they stated that they had some knowledge about learners. Moreover, it was concluded that participants emphasized the importance of using different instructional strategies but most of them used teacher centered methods in practice.

Uşak (2009) in his another study, studied PCK of pre service science teacher's in the topic of cell. Six participants were involved in the study and for data collection lesson preparation, laboratory plan, semi-structured interview and concept maps were

used. Results showed that participants' had enough SMK in terms of cell. It was also concluded that pre service science teachers' had inadequate knowledge related to knowledge of students. Curriculum knowledge of participants was also adequate and regarding assessment knowledge they had knowledge in using different types of assessment methods while teaching.

The other study was carried out by Canbazoğlu (2008) in Gazi University. The purpose of the study was to examine pre service science teachers' PCK in structure of matter topic. For selecting the subjects of the study, SMK test was applied to 40 participants and of them 5 pre service science teachers were chosen with different knowledge level. Case study design was adopted and data were gathered through observations, interviews and document analysis. The main findings indicated that participant who had teaching experience had better PCK than participants who did not have any experience. When the results of PCK components examined, in terms assessment, participants reported they had limited knowledge in alternative assessment methods and therefore preferred to use traditional methods in their teaching. For instructional strategies, participants also had few knowledge and did not use alternative methods. In knowledge of learners component, since participants did not have high level of SMK and still some misconceptions, they could not detect some misconceptions of students.

Different from the previous studies, Yiğit (2009) developed a program to improve pre service chemistry teachers' SMK and PCK in the topic of matter, chemical equilibrium and acids. 22 participants were involved in the study and the program lasted for five weeks. "Chemistry Concept Test (CCT) and "Chemistry Concept Test Form B (CCT-B) were used in order to collect data. Before starting the program CCT was administered and at the end of the program CCT-B was implemented. According to the results of the study, participants' level of knowledge in PCK was high at the end of the program. The program improved participants' knowledge in terms of detecting misconceptions and the ways of eliminating them.

The other study was carried out in order to examine the relationship among PCK components regarding ozone layer depletion (Kaya, 2009). Participants of the study

were comprised of 4th grade pre service science teachers. The sample consisted of 216 participant and they were given a survey. Later, based on the scores of survey, 25 participants from different groups were chosen to be interviewed. Results indicated that there was a relationship between knowledge of curriculum, instructional strategies and learner components. Results of knowledge of assessment component showed that participants had low knowledge in assessment component and they did not prefer to use alternative ways of assessment. Similarly, related to curriculum knowledge, participants did not have necessary knowledge. Finally, significant relation was found between SMK and PCK of pre service science teachers. Participants who had high level of SMK, also had high level knowledge in curriculum, learners and instructional strategies.

Mıhladız and Timur (2011) studied with 4th grade pre service science teachers in order to examine their opinions about in service science teachers' PCK. A focus group interview was conducted and data were analyzed by descriptive and content analysis. Firstly, participants indicated that in service teachers' had limited SMK. Regarding with the knowledge of instructional strategies, they pointed out that teachers' had inadequate knowledge since they generally use questioning and lecturing methods. Moreover, participants assessed in service teachers' knowledge of assessment as inadequate because they mostly preferred traditional ways and few teachers used alternative methods.

Adadan and Öner (2014) studied PCK in the context of teaching methods of chemistry course. They examined how pre service science teachers' PCK were developed throughout the course in the topic of behavior of gases by using Schneider and Plasmans' (2011) framework. They study was planned as case study and two participants who were in their last year in the program were selected by purposive sampling. Data were gathered via CoRe and interviews before and after the course. Based on the results, it was explained that before the course participants' PCK was not well developed and limited. After the course, their representation of PCK had improved but two participants did not show the same amount of improvement for the components of PCK. Participants' knowledge of science curriculum showed the least

improvement among other components due to the lack of experience whereas participants' improvement in terms of knowledge of students was the highest because of the other methods course they taken at the university. Therefore, it was concluded that courses in teacher education programs had influence on developing pre service teachers' knowledge of students. In terms of knowledge of chemistry teaching, one of the participants' progression was greater than the other one. This was explained by the different level of self-efficacy held by participants. Finally, related to knowledge of assessment both of the participants developed their representations. The study suggested that studies that monitoring participants' PCK for a long time period is needed.

Besides from the studies qualitative in nature regarding PCK, Aksu, Metin and Konyalıoğlu (2014) developed a PCK instrument and administered it to 768 participants from different departments. Pedagogical content knowledge scale (PCKS) included 38 items were applied to participants. Based on the analysis, three factors were extracted as follows: content knowledge, pedagogical knowledge and pedagogical content knowledge. In this scale, researchers did not examine the PCK components separately and indicated that the instrument could be applied to any departments in faculties of education. To conclude, they suggested that PCKS was valid and reliable instrument.

2.4. Summary of the Literature Review

This chapter reviewed the related literature broadly in terms of perceptions of pre service science teachers related to science teaching. It started with elementary science teacher education in Turkey in order to gain understanding about currently implemented science teacher program, main changes that HEC made in 2007 in the teacher education programs and examined some studies that made comparison between Turkish teacher education programs and other countries programs. It was seen that there are some differences in terms of entrance to the faculties of education, practicing hours in the program and supporting of beginning teachers in their first years.

Then, the review continued with the examination of science teacher knowledge based on the Abell's (2007) model of teacher knowledge. In this model, there were four types of science teacher knowledge and two of them, pedagogical knowledge and pedagogical content knowledge, are examined in detail. Regarding PK, it is concluded that there was few research in the literature conducted with pre service science teachers. In the light of the literature review, it could be concluded that there were differences in terms of the components of PK. The common component of PK in different studies was classroom management. However, although other components had various names, mostly they covered the similar constructs. Based on the literature, classroom management, learners and learning, lesson planning and assessment were considered as components of PK and each component was described in detail. Moreover, since this study investigated both PK and PCK of pre service science teachers, distinction between these two types of knowledge was emphasized.

Furthermore, regarding PK, the literature revealed that there were many models of PCK and some of them were presented broadly in this study. While presenting PCK models, differences between models and components were also mentioned. Moreover, based on Abell's model (2007), each component of PCK was examined in detail. This study covered four components of PCK as follows: knowledge of science instructional strategies, knowledge of science learners, knowledge of science curriculum and knowledge of science learners. Knowledge of science leaner component was measured in two categories: knowledge of misconceptions and knowledge of learners. Orientation towards teaching science component was not studied in the present study. Moreover, related to SMK and knowledge of context, a brief information was given in order to present complete picture of Abell's (2007) model of science teacher knowledge. Lastly, studies related to PK and PCK in international and in Turkish context were covered at the end of this chapter.

CHAPTER III

METHOD

This chapter presents the method used in the study. It includes the information regarding the design of the study, research questions, subjects of the study, data collection instruments, piloting the instruments, data analysis, data collection process, internal and external threats of the study.

3.1. Design of the Study

Survey design was used in the current study. The first reason for choosing survey design is surveys aim to get information from sample and identify the certain characteristics of population. Moreover, in surveys, data is collected by asking questions to the participants. Lastly, information from the sample is used to make inferences about the population (Fraenkel & Wallen, 2006). In the present study, a questionnaire was used for collecting data to describe perceptions of pre service science teachers' related to their PK and PCK in teaching science.

3.2. Research Questions

1. What are pre service science teachers' perceptions related to their pedagogical knowledge?
    1.1. Do pre service science teachers' perceptions related to their pedagogical knowledge and its dimensions (learners and learning, lesson planning, classroom management and assessment) differ in terms of gender?
    1.2. Do pre service science teachers' perceptions related to their pedagogical knowledge and its dimensions (learners and learning, lesson planning, classroom management and assessment) differ in terms of level of achievement?

2. What are pre service science teachers' perceptions related to their pedagogical content knowledge?
    2.1. Do pre service science teachers' perceptions related to their pedagogical content knowledge and its dimensions (knowledge of instructional strategies, knowledge of learners, knowledge of assessment, knowledge of curriculum) differ in terms of gender?
    2.2. Do pre service science teachers' perceptions related to their pedagogical content knowledge and its dimensions (knowledge of instructional strategies, knowledge of learners, knowledge of assessment, knowledge of curriculum) differ in terms of level of achievement?

3.3. Subjects of the Study

Target population of the present study is all senior science teacher candidates currently enrolled in the elementary science education departments of the faculties of education in Turkey. Since it is not possible to administer the survey every member of target population, accessible population is identified. The accessible population is all the 4^{th} year students attending the state universities having elementary science education departments in Ankara, so the study was conducted on the accessible population. The reason for choosing fourth year students was that they were about to complete method and pedagogical courses and they have been in the program for a long time. As there are three state universities having elementary science education departments in Ankara, data were collected from all these three universities. 36.4 % (n=64) of data was gathered from Gazi University, 47.7 % (n=84) from Hacettepe University and % 15.9 (n=28) from Middle East Technical University. The approximate number of fourth grade pre service science teachers in state universities of Ankara in 2014/2015 semester was 230 and 176 participants were involved in the present study (*N*=176). Table 3.1 provides students' distribution according to their university.

Table 3.1

Distribution of Participants According to Their University (N=176)

University	*n*	*%*
Gazi	64	36.4
Hacettepe	84	47.7
METU	28	15.9

Demographic characteristics of participants (gender, type of high school, their GPA and desire to teach) are given in Table 3.2. Of the participants, 77.3 % were female and 22.7 % were male. When the type of school that participants' graduated considered, it is seen that participants mostly graduated from Anatolian high school (n=85, 48.3%) and general high school (n=63, 35.8). Participant who answered this item as 'other' did not specify his/her response.

Table 3.2

Demographic Characteristics of the Participants (N=176)

	f	*%*
Gender		
Female	136	77.3
Male	40	22.7
Type of High School		
Anatolian High School	85	48.3
Anatolian Teachers High School	25	14.2
General High School	63	35.8
Private High School	2	1.1
Others	1	.60
GPA		
Satisfactory	92	52.3
Honor	68	38.6
High Honor	16	9.1
Desire for Teaching		
Agree	170	96.6
Not Sure	5	2.8
Disagree	1	.60

In terms of academic achievement, participants were asked to write their general grade point average (CPGA) in seventh semester. All of participants answered the item. While coding the data, grades between 2.00 and 2.99 were coded as satisfactory, grades between 3.00 and 3.49 were coded as honor and grades between 3.50 and 4.00 were coded as high honor. According to the results, 52.3% (n=92) of the students were satisfactory, 38.6% (n=68) of them were honor and, 9.1% (n=16) of them were high honor. The range of their CPGA was between 2.02 and 3.72 out of 4.00.

When participants were asked their desire to teach after graduation, majority of the participants (n=170, %96.6) answered that they want to become a teacher while 2.8 % (n=5) of them were not sure and only one student did not want to teach.

3.4. Data Collection Instruments

Two questionnaires were utilized in the current study. These are Perceptions of Knowledge and Skills in Teaching (PKST) (Choy, Lim, Chong & Wong, 2012) and Scale for Pre Service Science Teachers Perception Related to Their PCK (Bukova-Güzel, Cantürk-Günhan, Kula, Özgür, & Elçi, 2013). Detailed information is given about the instruments in the following sections.

3.4.1. Perceptions of Knowledge and Skills in Teaching (PKST) Scale

The PKST instrument including 38 items was developed by Choy, Lim, Chong and Wong (2012). It aims to present perceptions of pre service teachers and teachers that newly began to teaching related to their PK. Participant rated their perceptions regarding PK on a 5 point Likert scale and in the original scale the scale ranged between “no knowledge at all” to “complete knowledge”. Reliability of the original instrument was found .95 and it involved six components as student learning, lesson planning, instructional support, accommodating diversity, classroom management and care and concern. Cronbach’s alfa values of each components were .83, .82, .77, .71, .80, and .81 respectively.

The instrument was translated into Turkish by an expert from school of foreign language and by a bilingual translator who is speaking fluently English and Spanish. Then, two experts from the department of educational sciences and two teachers, one of them is science teacher and one of them is Turkish teacher, reviewed the instrument and examined the consistency of the items with the original instrument. Necessary changes were made based on the suggestions like using different words in statements in order to make the meaning clear and final form of the instrument was formed. Detailed information about Turkish version of the instrument is presented in the following sections.

3.4.2. Scale for Pre Service Science Teachers' Perceptions Related to Their PCK

The instrument was originally developed by Bukova-Güzel, Cantürk-Günhan, Kula, Özgür and Elçi (2013) to identify perceptions of pre service mathematics teachers regarding their PCK. It was later adapted by the researcher to perceptions related to science teaching. The major change was replacing the word "mathematics" by "science". Also, one of the components, which was related with knowledge of mathematical language and symbols was removed and knowledge of assessment sub dimension was added. The reason for removing the sub dimension was that in science curriculum symbols are not used. Knowledge of assessment, which is a component of PCK according to Abell's model (2007), was missing in the original instrument and was added as a component. In this way, the questionnaire was adapted to science teachers' perceptions related to their PCK and administered to a large sample for validation in the pilot study. The Cronbach alpha value of the original instrument was found .87. Factors of original scale and their Cronbach's alfa values are given in Table 3.3.

Table 3.3

Cronbach Alpha Values for Factors of Perceptions of Pre Service Mathematics Teachers' Related to Their PCK

Factors	*a*
Knowledge of Teaching Strategies	.78
Knowledge of Mathematical Language and Symbols	.60
Knowledge of Misconceptions	.73
Knowledge of Learners	.64
Knowledge of Curriculum	.83

3.5. Piloting the Instruments

3.5.1. Piloting the Perceptions of Knowledge and Skills in Teaching (PKST)

The instrument was piloted with 193 pre service teachers at Ege University in April 2015. Since the instrument was related with perceptions of pedagogical knowledge which is not subject specific (Grossman, 1990), departments of science education, computer education and instructional technologies, Turkish language teaching, social studies and classroom teaching were included in pilot study.

Exploratory factor analysis (EFA) was conducted in order to specify how many factors are present in the scale (Tabachnick & Fidell, 2007). Before conducting factor analysis, assumptions were checked. According to Bryman and Cramer (as cited in Çokluk, Şekercioğlu & Büyüköztürk, 2014) in order to conduct EFA the minimum number of participants should be the larger than five or ten times the number of variables. In the present study, this assumption was not violated since 193/38=5.08. Moreover, in order to examine sample size was appropriate or not for conducting factor analysis, Kaiser-Meyer-Olkin should be more than .60 (Kaiser, 1974, as cited in Pallant, 2010). Moreover, Bartlett's test of sphericity should be less than $p<.05$ (Barlett, 1954, as cited in Pallant, 2010). In the study, Kaiser-Meyer-Olkin (KMO) was .91 which was greater than the critical value and Bartlett's test of sphericity met indicated criteria ($p=.000<.05$). The sample size for the pilot study was assured.

Principal component analysis (PCA) is used because it is common to use PCA when the purpose is to lower the number of variables into smaller number of variables and this technique allows the researcher to examine the factor structure of the instrument (Tabachnick & Fidell, 2007). For factor extraction, components having an eigenvalue of 1 or more should be considered as important factors (Çokluk, Şekercioğlu & Büyüköztürk, 2014). It is also needed to look the scree plot as seen in Figure 3.1.

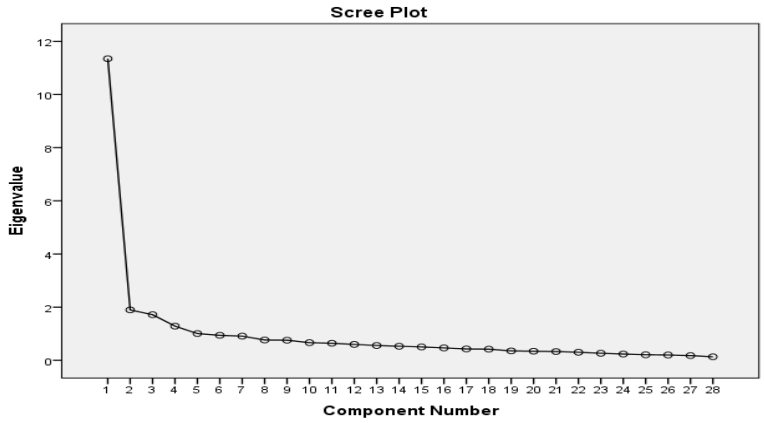

Figure 3.1 Scree Plot of PKST

According to results of analysis, there were five components with Eigenvalue higher than 1 and this explains the 58.02 % of the variance. When scree plot was examined, it was decided to include four components since there were four factors after breaking point as presented in Figure 3.1. These four components explained the 58.02 % of the variance as seen in Table 3.4.

Table 3.4

Total Variance Explained by the Components of PKST

Factors	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Factor 1	11.35	40.52	40.52	11.35	40.52	40.52
Factor 2	1.90	6.77	47.30	1.90	6.77	47.30
Factor 3	1.71	6.13	53.43	1.71	6.13	53.43
Factor 4	1.29	4.59	58.02	1.29	4.59	58.02

After deciding number of factors included in the instrument, Varimax with Kaiser Normalization rotation method was performed in order to interpret the components. In Varimax rotation the variance of loadings are maximized to simplify the factors (Tabachnick & Fidell, 2007). Two criteria were considered to determine the items of the factors. Tabachnick and Fidell (2007) explained that items should have at least .32 factor loading in order to take part in one component. .40 was determined as cut point for the factor loading in the present study. As Kim-Yin (2004, as cited in Çokluk, Şekercioğlu & Büyüköztürk, 2014) indicated in order to take .40 as cut point, the sample size should be minimum 200. Since in this study the pilot sample size was (*N*= 193) approximate to critical value, .40 was taken as a criteria for determining whether the item should be eliminated or not from the scale. Moreover, items that located in more than one component and difference between factor loadings were less than .01 should be eliminated from the instrument (Büyüköztürk, 2014). There were 38 items in the original instrument. Based on these criteria, 11 items (7, 9, 11, 17, 21, 25, 26, 28, 33, 37, and 38) were eliminated from the original scale respectively. In the final form there were 27 items. Factor loadings of items after the rotation are given in Table 3.5. The first component contributed to 40.52 % of the total variance, while the second component contributed nearly 6.77 %, third component 6.13 %, fourth component 4.59 %. Then, based on the related literature, factors were given names.

Table 3.5

Factor Loadings of PKST after the Rotation

	Factor Loadings After the Rotation				h^{2*}
Item No	Classroom Management	Learners &Learning	Lesson Planning	Assessment	
1		.74			.63
2		.78			.73
3		.44			.46
4		.62			.55
5		.62			.58
6		.58			.52
8		.67			.61

Table 3.5 (continued)

	Factor Loadings After the Rotation				h^{2*}
Item No	Classroom Management	Learners Learning	Lesson Planning	Assessment	
7			.62		.65
9			.41		.47
10			.55		.61
11			.62		.58
12			.80		.72
13			.75		.62
14				.74	.66
15				.80	.71
16				.66	.68
17				.43	.46
18	.67				.63
19	.61				.55
20	.71				.57
21	.55				.60
22	.55				.59
23	.53				.51
24	.57				.54
25	.57				.48
26	.71				.55
27	.60				.44

*communalities

To sum up, the adapted instrument has four dimensions different from the original instrument. This difference may occur due to the cultural differences and different education systems of the country from which the instrument was adapted. According to OECD report (2014), culture may have influence on GPK and therefore it might explain the differences between factor structures of the instrument.

When the items in the instrument were considered, the first factor was labeled as classroom management since it includes items related with using time efficiently, implementing group activities, and managing appropriate levels of difficulty of a task and preventing problems. The second factor named as learners and learning since it has items related to attracting students' attention to the lessons and improving their

thinking skills. The third factor was named as lesson planning because it is comprised of items related with planning the instruction and enabling resources. The last factor was named as assessment because this factor highlighted knowledge of preparing assessment tools and interpreting the results.

For reliability, the Cronbach Alfa was calculated and found .94 in the pilot study. As there were four dimensions, the Cronbach Alpha values were .86, .87, .85, and .84 respectively. The Cronbach's Alfa values and number of factors for the PKST instrument is presented in Table 3.6.

Table 3.6

Cronbach's Alfa Values and Number of Items in Each Factor

Factors	*Number of Items*	*Cronbach a*
Classroom Management	10	.87
Learners and Learning	7	.86
Lesson Planning	6	.85
Assessment	4	.80

3.5.2. Scale for Pre Service Science Teachers' Perceptions Related to Their PCK

Original version of perception of PCK scale was developed in Turkish language and resulted in five factor structures. Since the researcher has already a model related with the instrument, confirmatory factor analysis (CFA) was conducted using LISREL 9.2 program.

According to the first results of the CFA, chi square ($\chi 2$=237.75, p=.00) showed significant value with the ratio of $\chi 2/df$ =1.90. However, root mean square error of approximation (RMSEA) value of .092, comparative fit index (CFI) of .81, goodness of fit index (GFI) value of .81 and (IFI) of .81 indicated poor fit. Because of the poor fit, modification indices were examined. Item pairs which have high error covariance were ε6-ε5, ε15- ε14, ε7- ε2, ε7- ε5, ε11- ε5, ε11- ε7, ε9- ε6. Three modifications were considered between the item pairs ε6- ε5, ε15- ε14 and ε7- ε5 based on whether

the items were in the same factor or measured related constructs. After modifications were done, CFA was conducted again.

Results of the second analysis indicated that RMSEA value of .078 which is considered as acceptable fit (Tabachnick & Fidell, 2007). Moreover, the goodness of fit indices were found in acceptable level ($\chi 2$=200.14, *df*= 122 $\chi 2$/df =1.64, CFI=.91, IFI= .91, RMR= .34). According to Çokluk, Şekercioğlu and Büyüköztürk (2014) critical values and the limit values of PCK instrument results are given in Table 3.7.

Table 3.7

Results of CFA

Goodnes of fit index	PCK scale	Critical values
$\chi 2$/df	1.74	≤5
RMSEA	.078	.05 ≤ RMSEA ≤.08
RMR	.034	≤.10
CFI	.907	≥.90
IFI	.912	≥.90
GFI	.851	≥.90

CFI and IFI values indicated good fit but GFI value was lower than the expected value due to its' sensitivity to sample size (Çokluk, Şekercioğlu ve Büyüköztürk, 2014).

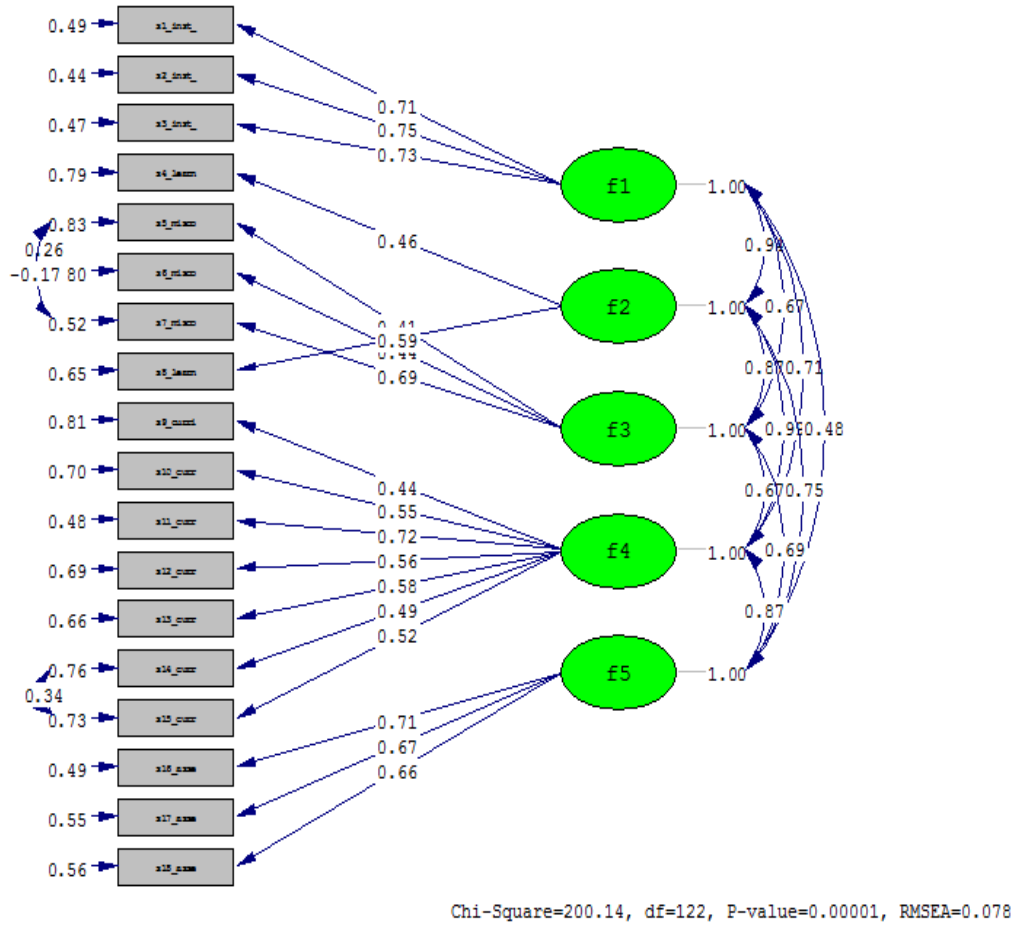

Figure 3.2 Five-Factor CFA Model of Perceptions of Pedagogical Content Knowledge Scale with Standardized Estimates

Result of the final model of CFA for the instrument indicated that standard estimates ranged between .44 and .83 as seen in Figure 3.1 and all the items were loaded on pre-determined factors similar to the original scale. As a result, perceptions of pedagogical content knowledge scale including 18 items and five factors were accepted as a model.

The Cronbach alpha reliability for the whole instrument was calculated as .88. For reliability analysis, *a* of .6-.7 is acceptable value and .8 or higher values accepted as good reliability (Cronbach, 1951). Cronbach alpha coefficient for each factor were provided in Table 3.8.

Table 3.8

Factors and Cronbach's Alfa Values of PCK Scale

Factors	*Number of Items*	*a*
Knowledge of Science Inst. Strategies	3	.77
Knowledge of Science Learners	2	.63
Knowledge of Science Misconcep.	3	.64
Knowledge of Science Curriculum	7	.75
Knowledge of Science Assessment	3	.72

3.6. Data Collection Procedure

After forming the final forms of the instruments, approval from the METU ethical committee was taken for ethical considerations (see Appendix B). Moreover, for collecting data from Hacettepe University researcher also applied to Hacetttepe University Ethical Committee and get permission (see Appendix C). In Gazi University, approval from METU Ethics Committee was accepted so there was no need to apply to Gazi University Ethical Committee. After getting necessary permissions, the dates in which instruments would be conducted were determined with the instructors from each university.

Two questionnaires were applied to the participants in their classrooms. Time for completing the instrument was approximately 15-20 minutes. At METU and Hacettepe University, researcher administered the questionnaire but at Gazi University, instrument was administered by another researcher who was also studying science education. Before conducting the instrument, other researcher who implemented the instruments was informed about the directions and the items in the scale. Before administering the instruments the researcher informed participants about the instrument and stayed in the classroom during the administration process to answer possible questions that may arise related to items.

Data collection period started in April 2015 and finished in May 2015. An informed consent form (see Appendix D) was given to each participant before conducting the instrument which included the purpose of the study, duration of administering the instrument and contact information of the researcher in case of any questions that

emerge in participants' mind after completing it. Moreover, confidentiality was ensured because participants' names were not used in any form or in any publication. Participants who read and signed the informed consent form were given the questionnaire. In METU and Hacettepe University, for participants who were not in the classroom at the data collection date, their instructor administered the instrument in the following week.

3.7. Data Analysis Procedure

The data obtained through instruments were analyzed using SPSS 20. Descriptive statistics was used in order to describe the basic characteristic of the data. Independent t test and one way ANOVA were conducted as inferential statistics to reach the conclusions.

For the demographic characteristic of the participants (university, gender, type of high school, level of achievement and desire for teaching) descriptive statistics were performed by calculating mean, standard deviations, frequencies, percentages and range. Moreover, to present pre service teachers' perceptions related to their PK and PCK again descriptive statistics were used and mean and standard deviations were calculated.

In order examine whether pre service science teachers' perceptions related to their PK and PCK differ in terms of gender, independent t test was calculated and assumptions were checked. In order to investigate whether perceptions of PK and PCK of pre service science teachers' differ according to level of achievement, one way ANOVA was used. Assumptions of one way ANOVA were checked and detailed information is presented in the following chapter.

Lastly, for the pilot study, exploratory factor analysis (EFA) was conducted for Perceptions of Knowledge and Skill in Teaching and confirmatory factor analysis (CFA) was performed for Perceptions related to PCK scale. In order to check reliability, Cronbach's Alpha values were calculated for each of them. In the present study, alpha level was considered as .05.

3.8. Limitations of the Study

This section includes information in terms of external and validity threats and the way of controlling possible threats.

3.8.1. External Validity Threats

External validity refers to "the extent to which the results of a study can be generalized determines the external validity of the study" (Fraenkel & Wallen, 2006, p.104). The study almost included all fourth year pre service science teachers in state universities of Ankara and investigated their perceptions related to science teaching. However, generalization of the results of the current study is limited. It could be generalized for pre service science teachers similar in characteristics and have common background properties with the accessible population of the study.

3.8.2. Internal Validity Threats

The potential internal threats for the current study are presented below.

To begin with, according to Fraenkel and Wallen (2006) subject characteristics threat is "the selection of people for a study may result in the individuals differing from one another in unintended ways that are related to the variables to be studied" (p. 170). This threat was tried to be controlled by selecting subjects from the same grade level and in order to reduce the effect of socioeconomic status level all subjects were selected from the state universities. However, since the medium of instruction at METU is English whereas at Hacettepe and Gazi University medium of instruction is Turkish, participants from METU may not had been aware of some of the Turkish terminology related to PK and PCK in the questionnaires. Therefore, this situation might have affected the findings of the study.

Moreover, in order to minimize the loss of subjects, the day of implementation of instrument was announced beforehand by the instructors and participants who were absent in data collection day were given the instrument in the following week if she/he was volunteer to participate in.

The other possible threat is location since different universities were involved in the study. For controlling location threat data were collected in the classrooms and it was applied in the morning. It was tried to ensure the data collection places similar to each other in different universities.

Furthermore, instrumentation was another threat for the present study. In two universities, the instrument was applied by the researcher but in Gazi University it was administered by a different researcher. To standardize data collection procedure, the other researcher was given information about the purpose of the study, duration of administration and direction of the instrument. In this way, instrumentation threat was tried to be controlled.

Testing was not a threat for the present study since data were not collected over a period of time and the study was not designed as an intervention study. The instruments were applied once to the participants.

Additionally, history threat occurs when unplanned or unexpected event happens in the course of the study (Fraenkel and Wallen, 2006). There seems no such things occurred during data collection process.

CHAPTER IV

RESULTS

This chapter includes information regarding the results of the study. It includes three main parts. In the first part, results on pre service science teachers' perceptions related to PK and its' sub-dimensions are provided while in the second part results on participants' perceptions related to their PCK and its sub-dimensions are presented in detail by using descriptive and inferential statistics. At the end, summary of the results are given.

4.1. Results on Pre Service Science Teachers' Perceptions Related to Their Pedagogical Knowledge (PK)

First research question aims to investigate pre service science teachers' perceptions related to PK. Data were analyzed by using descriptive statistics. The Likert scale ranged from "no knowledge at all" (1) to "complete knowledge" (5). The overall mean value for the pre service science teachers' perceptions related to PK was 4.14 (*SD*=.84) and mean scores ranged between 3.86 and 4.40. In the study, higher mean value indicated that participants perceived themselves as to have higher perceptions related to their PK. Mean, standard deviation, minimum and maximum values were calculated for each dimension and provided in Table 4.1.

Table 4.1

Descriptive Statistics for Dimensions of Perceptions Related to PK (N=176)

	M	*SD*
Learners and Learning	4.16	.86
Lesson Planning	4.20	.83
Assessment	4.24	.80
Classroom Management	4.03	.88

According to the results, mean scores of learners and learning (*M*=4.16, *SD*=.86), lesson planning (*M*=4.20, *SD*=.83) and assessment (*M*=4.24, *SD*= .80) were close to each other and considered as being close to complete knowledge. Their standard deviation scores were also very close to each other. On the other hand, mean scores of classroom management (*M*=4.03, *SD*=. 88) was lower than the other three dimensions. Descriptive statistics for each item is given in Table 4.2.

Table 4.2

Descriptive Statistics for PKST

Items	*M*	*SD*	1-2*	3**	4-5***
Learners and Learning					
1. Developing students' interest in learning	4.10	.78	5.7	6.8	87.5
2. Arousing students' interest towards subject	4.26	.76	5.7	2.3	92.1
3. Including critical thinking appropriately in the lessons	4.00	.94	9.7	9.7	80.7
4. Including creative thinking appropriately in the lessons	4.06	.91	10.8	2.3	87.0
5. Facilitating and stimulating thinking among students	4.20	.88	8.6	3.4	88.1
6. Using student-centered teaching and learning activities	4.37	.86	7.4	1.1	91.5
8. Asking students the right questions to facilitate their learning	4.19	.82	6.9	3.4	89.8
Lesson Planning					
7. Choosing appropriate teaching strategies for teaching particular topics	4.23	.81	5.7	4.5	89.8
9. Planning lessons that take into consideration the different abilities of students	4.13	.87	8.0	8.5	83.5
10. Determining appropriate teaching methods	4.22	.82	5.7	7.4	86.9
11. Planning student centered lessons	4.40	.77	4.5	4.0	91.4
12. Producing teaching materials	4.19	.83	6.9	4.0	89.2
13. Acquiring appropriate teaching materials	4.04	.87	6.9	13.6	79.5

Table 4.2 (continued)

Items	*M*	*SD*	1-2*	3**	4-5***
Assessment					
14. Designing assessment tools (e.g., written tests, oral tests, science practical, etc.)	4.33	.78	4.5	5.7	89.7
15. Interpreting student' performance from test scores	4.24	.77	5.1	5.1	89.8
16. Using appropriate forms of assessment	4.18	.83	6.9	4.5	88.6
17. Using evaluative feedback to assist students in their progress	4.23	.83	6.3.	5.1	88.6
Classroom Management					
18. Teaching according to students' pace.	4.37	.82	6.3	2.8	90.9
19. Diagnosing students' learning difficulties.	4.22	.87	6.9	6.8	86.4
20. Managing individual students' learning effectively.	4.03	.80	7.4	8.0	84.6
21. Applying appropriate classroom management techniques.	4.03	.87	8.0	12.5	79.5
22. Managing students with behavioral and learning problems.	3.86	.98	10.8	19.9	69.3
23. Using appropriate strategies to monitor student behavior.	4.13	.90	9.1	5.7	85.2
24. Managing student discipline.	3.95	.90	9.1	13.6	77.2
25. Managing time effectively.	3.95	.93	8.6	18.8	72.8
26. Having coping skills.	3.92	.90	9.1	15.3	75.5
27. Managing stress.	3.86	.91	9.6	17.0	73.3

*percentage of no knowledge and little knowledge ** percentage of moderate knowledge

***percentage of quite knowledge and complete knowledge

Results indicated that a majority of the participants responded the items in learners and learning dimensions as to have complete knowledge and quite knowledge. The mean values for the items in this dimension ranged between 4.00 and 4.37. Mean scores for developing students' interest in learning (M= 4.10, SD=.78), including critical thinking appropriately in the lessons (*M*=4.00, *SD*=.94), including creative thinking skills in the lessons (*M*=4.06, *SD*=.91), arousing students' interest towards subject (*M*=4.26, *SD*=.76), facilitating and stimulating thinking among students

(*M*=4.20, *SD*=.88), using student centered teaching and learning activities (*M*=4.37, *SD*=.86) and asking right questions to facilitate their learning (*M*=4.19, *SD*=.82) were close to value of "having quite knowledge". As seen from the Table 4.2, mean values of items were above 4.00 that indicates participants had positive perceptions.

In terms of lesson planning, similar to the learners and learning dimension, majority of the participants rated the items as having "quite" and "complete" knowledge. The mean values for the items in this dimension ranged between 4.04 and 4.40. According to Table 4.2 results revealed that participants perceived themselves to have quite knowledge related to choosing appropriate teaching strategies for teaching particular topics (*M*=4.23, *SD*=.81), determining appropriate teaching methods (*M*=4.22, *SD*=.82), planning student centered lessons (*M*=4.40, *SD*=.77), producing teaching materials (*M*=4.19, *SD*=.83), planning lessons that take into consideration the different abilities of students (*M*=4.13, *SD*=.87) and acquiring appropriate teaching materials (*M*=4.04, *SD*=.83).

As seen in Table 4.2, descriptive statistics for assessment dimension indicated that most of the participants generally perceived themselves as knowledgeable. The mean values of items for this dimension ranged between 4.18 and 4.33. Participants reported that in terms of designing assessment tools (*M*=4.33, *SD*=.78), interpreting students' performance from test scores (*M*=4.24, *SD*=.77), using appropriate forms of assessment (*M*=4.18, *SD*=4.23) and using evaluative feedback to assist students in their progress (*M*=4.23, *SD*=.83) they feel themselves competent.

Although classroom management dimension has the lowest mean value (*M*=4.03, *SD*=.88) among other three dimensions, most of the participants felt that they have quite knowledge in relation to classroom management. The mean values ranged between 3.86 and 4.37. As displayed in Table 4.2, items related to classroom management with the higher mean values were teaching according to students' pace (*M*=4.37, *SD*=.82), diagnosing students' learning difficulties (*M*=4.22, *SD*=.87), using appropriate strategies to monitor student behavior (*M*=4.13, *SD*=.90), managing individual students' learning effectively (*M*=4.03, *SD*=.80) and applying appropriate classroom management techniques (*M*=4.03, *SD*=.87). On the other

hand, perceptions with the lower mean values for this dimension were managing students with behavioral and learning problems (*M*=3.86, *SD*=.98), managing students discipline (*M*=3.95, *SD*=.90), managing time efficiently (*M*=3.95, *SD*=.93), having coping skills (*M*=3.92, *SD*=.90), managing stress (*M*=3.86, *SD*=.91) which were between moderate and quite knowledge.

4.1.1. Results on Pre Service Science Teachers' Perceptions Related to Their PK According to Gender

One of the sub research questions of the first research question aimed to investigate whether gender had influence or not on pre service science teachers' perceptions related to their PK. Independent samples t test was used in order to make comparison between mean differences of female and male participants' perceptions in terms of overall PK and its dimensions.

Before conducting analysis, assumptions of independent samples t-test were controlled. These assumptions were independent observation, normality and homogeneity of variance (Green & Salkind, 2011). For independent observation, it was assumed that observations within each sample were independent from each other. In order to check normality, Skewness and Kurtosis values, Kolmogorov-Smirnov test and histogram were used. Skewness and Kurtosis values for groups were between +3 and -3 and normality assumption was validated according to Tabachnick and Fidell (2007) for overall PK and for dimensions of PK. On the other hand, Kolmogorov-Shapiro-Wilk test results indicated that normality assumption was violated since the results were significant ($p < .05$). However, relatively large sample size (*N*=176) for the present study could be considered as not to violate normality assumption (Gravetter & Wallnau, 2010). The histogram also appeared to be reasonably normally distributed. Therefore, normality assumption was ensured.

In order to check homogeneity of variance assumption, Levene's Test was used. This assumption is not violated ($p > .05$) since the values for overall PK ($p = .95$), learners and learning ($p = .24$), lesson planning ($p = .87$), assessment ($p = .90$) and classroom management ($p = .68$) were not significant.

After checking assumptions, independent samples t-test was performed. Results of independent t test for perceptions related to PK of participants according to gender are displayed in Table 4.3.

Table 4.3

Independent Samples t-test Results of Perceptions Related to PK According to Gender

	Gender	*N*	*M*	*SD*	*t*	*p*
Perceptions related to PK	Female	136	4.14	.65	.37	.07
	Male	40	4.10	.63		

As seen in Table 4.3, results showed that there was no statistically mean difference between female participants' perceptions (*M*=4.14, *SD*=.65) and male participants' (*M*=4.10, *SD*=.63) perceptions related to their PK, *t* (174) = .37, *p*> .05.

When the dimensions of PK examined separately, results were non-significant according to participants' gender. The results of independent t test for perceptions related to the dimensions of PK are given in Table 4.4. There was no statistically mean difference in perceptions of learners & learning dimension between female participants (*M*=4.19, *SD*=.71) and male participants (*M*=4.09, *SD*=.78); *t* (174) = .68, *p*. >05. Similarly, results pertinent to lesson planning, (*t* (174) = .75, *p* > .05), assessment (*t* (174) = .72, *p*>. 05) and classroom management *t* (174) =.29, *p*> .05) were non-significant.

Table 4.4

Independent Samples t-test Results of Perceptions Related to Dimensions of PK According to Gender

Factors	Gender	*M*	*SD*	t	*p*
Learners and Learning	Female	4.19	.71	.68	.50
	Male	4.09	.78		
Lesson Planning	Female	4.22	.70	.75	.45
	Male	4.13	.66		

Table 4.4 (continued)

Factors	Gender	*M*	*SD*	t	*p*
Assessment	Female	4.27	.71	.72	.47
	Male	4.17	.72		
Classroom Management	Female	4.02	.70	.29	.77
	Male	4.06	.76		

4.1.2. Results on Pre Service Science Teachers' Perceptions Related to Their PK According to Level of Achievement

The second sub-research question pertaining to first research question concerned with if pre service science teachers' perceptions related to their PK differ in terms of level of achievement. Level of achievement had three levels: satisfactory (ranged between 2.02 and 2.89), honor (ranged between 3.06 and 3.44) and high honor (ranged between 3.51 and 3.72). The one way analysis of variance (ANOVA) was performed to investigate this research question. Assumptions of one-way ANOVA were independent observation, normality and homogeneity of variance (Green & Salkind, 2011) which were given in details in previous section for the present data. In order to check whether mean differences between satisfactory, honor and high honor were significant or not one-way ANOVA was carried out. According to Table 4.5, the result of analysis showed that level of achievement did not have any significant effect on participants' perceptions related to their PK, F (2, 173) = 1.55, p=.22. Because the results were non-significant, there was no need to report eta squared and conduct Tukey and Scheffe tests.

Table 4.5

One Way ANOVA Results of Perceptions Related to PK According to Level of Achievement

Source	*SS*	*df*	*MS*	*F*	*p*
Between Groups	1.29	2	.65	1.55	.22
Within Groups	72.07	173	.42		
Total	73.36	175			

This research question also aimed to identify if pre service science teachers' perceptions related to dimensions of PK differ in terms of level of achievement. To answer this question, a series of one way ANOVA were conducted and results were summarized in Table 4.6. Results suggested that level of achievement did not have significant effect on participants' perceptions related to learners & learning F (2, 173) = .99, p=.37, lesson planning F (2, 173) = .90, p=.15, assessment F (2, 173) = .87, p=.42, and classroom management F (2, 173) = 1.37, p=.26. Therefore, post-hoc comparisons were not performed.

Table 4.6

One Way ANOVA Results of Dimensions of Perceptions Related to PK According to Level of Achievement

		SS	*df*	*MS*	*F*	*p*
Learners&Learning	Between Groups	1.04	2	.52	.99	.37
	Within Groups	90.34	173	.52		
	Total	91.38	175			
Lesson Planning	Between Groups	1.80	2	.90	1.91	.15
	Within Groups	81.24	173	.47		
	Total	83.03	175			
Assessment	Between Groups	.88	2	.44	.87	.42
	Within Groups	87.43	173	.51		
	Total	88.31	175			

Table 4.6 (continued)

		SS	*df*	*MS*	*F*	*p*
Classroom man.	Between Groups	1.39	2	.69	1.37	.26
	Within Groups	87.70	173	.51		
	Total	89.08	175			

4.2. Results on Pre Service Science Teachers' Perceptions Related to Their Pedagogical Content Knowledge

Other research question investigated pre service science teachers' perceptions related to their PCK. The Likert scale range from never (1) to always (5). Items with the higher mean value revealed that participants perceived that they have high level of PCK. The overall mean value for the pre service science teachers' perceptions related to PCK was 4.07 (*SD*=.90) and mean scores ranged between 3.86 and 4.40. To identify participants' perceptions, mean, standard deviation, minimum and maximum values were calculated for each dimension and presented in Table 4.7.

Table 4.7

Descriptive Statistics for Dimensions of Perceptions Related to PCK

	M	*SD*
Knowledge of Science Inst. Strategies	4.15	.95
Knowledge of Science Learners	3.98	.96
Knowledge of Science Misconceptions	3.77	.97
Knowledge of Science Curriculum	4.17	.89
Knowledge of Science Assessment	4.08	.92

According to Table 4.7 descriptive results indicated that mean scores of knowledge of instructional strategies (*M*=4.15, *SD*=.95), knowledge of curriculum (*M*=4.17, *SD*=.89) and knowledge of assessment (*M*=4.08, *SD*=.92) were regarded as close to having quite knowledge. On the other hand, knowledge of misconceptions (*M*=3.77, *SD*=.97) and knowledge of learners (*M*=3.98, *SD*=.96) dimensions had lower mean

values compared to other three dimensions. Descriptive results for each item are described in Table 4.8.

Table 4.8

Descriptive Statistics for Perceptions Related to PCK

Items	*M*	*SD*	1-2*	3**	4-5***
Knowledge of Science Inst. Strategies					
1. I can arrange activities while teaching science concepts	3.88	1.10	16.5	8.0	75.6
2. I can link science concepts to daily life	4.32	.90	9.1	2.3	88.7
3. I can use analogies while teaching science concepts	4.25	.85	7.4	4.0	88.7
Knowledge of Science Learners					
4. I know students' prior knowledge in a given topic	3.93	.95	12.5	9.1	78.4
8. I can select activities that are appropriate students' developmental level.	4.03	.95	13.1	5.1	81.8
Knowledge of Science Misconcep.					
5. I can anticipate students' difficulty areas in a given topic	3.77	.97	14.8	14.2	71.0
6.I know the students' possible misconceptions in a given topic	3.73	.94	12.5	18.2	69.3
7. I can arrange activities that do not cause misconceptions	3.81	1.00	12.5	18.8	68.7
Knowledge of Science Curriculum					
9. I have knowledge about the purposes of the elementary science curriculum	4.24	.85	5.1	9.7	85.2
10. I can prepare a lesson plan in a given topic	4.23	.92	6.3	13.1	80.7
11. I prepare lesson plans that relate purposes of elementary science curriculum and needs of students	4.21	.91	9.1	4.0	87.0
12. I consider the objectives of the topic while preparing lesson plan	4.53	.73	4.0	2.3	93.8
13. I can use assessment tools in elementary science curriculum	4.12	.92	9.7	7.4	82.9

Table 4. 8 (continued)

Items	*M*	*SD*	1-2*	3**	4-5***
14. I can assess the effectiveness of the activities in terms of creating science concepts	3.97	.92	10.8	10.8	78.4
15. I can use assessment results to plan/improve the instruction	4.05	.95	11.4	8.0	80.7
Knowledge of Science Assessment					
16. I can evaluate students' knowledge by using a variety of assessment tools (written / oral exams , portfolios, posters, self-evaluation and so on	4.22	.91	9.1	5.7	85.3
17. I can develop various assessment tools appropriate for the elementary science curriculum	3.98	.93	10.2	13.6	76.1
18. I have the knowledge of different assessment methods in science teaching	4.05	.93	10.2	9.7	80.2

*percentage of never and rarely ** percentage of undecided
***percentage of usually and always

Descriptive results for knowledge of science instructional strategies dimension revealed that majority of participants perceived themselves as having high level of knowledge (mean values ranged between 3.88 and 4.25). Mean score of the participants for the linking science concepts to daily life (*M*=4.32, *SD*=.90) and using analogies while teaching science concepts (*M*=4.25, *SD*=.85) were high and above the overall mean score of PCK. The mean value of item which was related with arranging activities while teaching science (*M*=3.88, *SD*=1.10) was lower than the other mean scores in the present dimension.

Results of the second dimension indicated that most of the participants responded the first (78.4%) and second item (81.8%) in knowledge of learners dimension as always and usually. The mean scores of the participants for knowing students' prior knowledge in a given topic (M=3.92, SD=.95) and selecting activities that are appropriate to students' developmental level (M=4.03, SD=.95) were close to each other with the same standard deviation value.

In terms of knowledge of misconceptions dimension, mean values of the items have the lowest mean values among other items in the instrument. As seen in Table 4.8 mean values ranged between 3.73 and 3.81. Participants tended to rate undecided for the items anticipating students' difficulty areas in a given topic (*M*=3.77, *SD*=.97), knowing the students' possible misconceptions in a given topic (*M*=3.73, *SD*=.97) and arranging activities that does not cause misconceptions (*M*=3.81, *SD*=1.00).

Furthermore, results of the knowledge of curriculum dimension revealed that majority of the participants perceived themselves as having high level of curriculum knowledge. Most of the participant perceived their knowledge as high in terms of having knowledge about the purposes of elementary science curriculum (*M*=4.24, *SD*=.85), preparing lesson plan in a given topic (*M*=4.23, *SD*=.92), preparing lesson plans that relate the purposes of elementary science curriculum and needs of students (*M*=4.21, *SD*=.91), considering the objectives of the topic while preparing lesson plan (*M*=4.53, *SD*=.72), capable of using assessment tools in elementary science curriculum (*M*=4.12, *SD*=.92) and capable of using assessment results to plan/improve the instruction (*M*=4.05, *SD*=.95) Only one item which was asking assessing the effectiveness of the activities in terms of creating science concepts (*M*=3.97, *SD*=.91) had a mean value lower than 4.00.

The last dimension was asking for perceptions related to knowledge of assessment. According the Table 4.8, mean values ranged between from 3.98 to 4.22. Participants felt themselves more competent in terms of evaluating students' knowledge by using variety of assessment tools (*M*=4.22, *SD*=.91) and having knowledge about different assessment methods in science teaching (*M*=4.05, *SD*=.93). Mean value for the item related with developing various assessment tools appropriate for the elementary science curriculum (*M*=3.98, *SD*=.93) was lower than the other two items in this dimension.

4.2.1. Results on Pre Service Science Teachers' Perceptions Related to Their PCK According to Gender

Investigation of whether pre service science teachers' perceptions related to PCK differ or not in terms of gender is one of the sub research questions belonging to the second research question. Independent sample t-was carried out in order to investigate the mean differences between female and male participants in overall PCK and in its five dimensions.

Before analysis of data, assumptions of independent sample t test (independent observation, normality and homogeneity of variance) were checked (Green & Salkind, 2011). In terms of independent observation, it was assumed that two observations were independent from each other. For normality, Skewness and Kurtosis values and histograms were checked. Skewness and Kurtosis values should be close to zero and values should not exceed +3 or -3 (Tabachnick& Fidell, 2007). The Skewness values ranged between -1.2 and -.78 and Kurtosis values ranged between .32 and 1.18 for all dimensions of PCK and overall PCK. Histogram also reasonably distributed normally, so normality assumption was not violated.

For homogeneity of variance assumption Levene's test was checked. Results indicated that overall PCK, knowledge of assessment, knowledge, curriculum, knowledge of misconceptions, knowledge of learners and knowledge of instructional strategies were not violated the homogeneity of assumption since the test results were non-significant (p>.05). After assumptions were checked, independent samples t -test was carried out to show whether mean scores were significantly different or not in terms of gender. Results revealed that female pre service science teachers' perceptions of PCK (*M*=4.07, *SD*=.69) was not statistically different than male pre service science teachers' perceptions of PCK (*M*=4.06, *SD*=.68); *t* (174) =.03, *p*> .05) as summarized in Table 4.9.

Table 4.9

Independent Samples t-test Results of Perceptions Related to PCK According to Gender

	Gender	*N*	*M*	*SD*	*t*	*p*
Perceptions related to PCK	Female	136	4.07	.69	.030	.98
	Male	40	4.06	.68		

When the dimensions examined separately, the results showed that regarding gender there was no statistically significant difference in pre service science teachers' perceptions regarding knowledge of instructional strategies (t (174) =.83, p> .05), knowledge of learners t (174) =.063, p> .05), knowledge of misconceptions t (174) =1.01, p> .05, knowledge of curriculum t (174) =.47, p> .05, and knowledge of assessment t (174) =.83, p> .0 as seen in Table 4.10

Table 4.10

Independent Samples t test Results of Perceptions Related to Dimensions of PCK According to Gender

	Gender	*M*	*SD*	t	*p*
Knowledge of Inst. Strategies	Female	4.16	.81	.22	.83
	Male	4.12	.77		
Knowledge of Learners	Female	3.98	.86	.063	.95
	Male	3.99	.80		
Knowledge of Misconceptions	Female	3.73	.89	1.01	.31
	Male	3.89	.77		
Knowledge of Curriculum	Female	4.21	.70	.47	.64
	Male	4.15	.72		
Knowledge of Assessment	Female	4.08	.83	.11	.91
	Male	4.06	.84		

4.2.2. Results on Pre Service Science Teachers' Perceptions Related to Their PCK According to Level of Achievement

The other sub research question examined whether level of achievement had any effect on participants' perceptions related to their PCK and dimensions of PCK. One-way ANOVA was conducted to answer these questions. Assumptions of ANOVA which were independent observation, normality and homogeneity of variance were examined for the present data while conducting independent sample t test for the previous research question. Therefore, one way ANOVA was performed directly. Table 4.11 presents the results of one-way ANOVA for the perceptions of overall PCK. As seen in Table 4.11 pre service science teachers' perceptions related to PK did not differ in terms of level of achievement, F (2, 173) = .89, p=.41. Therefore, post-hoc comparison tests were not carried out.

Table 4.11

One Way ANOVA Results of Perceptions Related to PCK According to Level of Achievement

Source	*SS*	*df*	*MS*	*F*	*p*
Between Groups	.85	2	.42	.89	.41
Within Groups	82.53	173	.48		
Total	83.38	175			

Moreover, result of perceptions related to dimensions of PCK is given in Table 4.12. According to the table, none of the ANOVA results were significant. Findings suggested that level of achievement had not a significant effect on participants' perceptions related to knowledge of instructional strategies F (2, 173) = 1.02, p=.36, knowledge of learners F (2, 173) = 1.18, p=.31, knowledge of misconceptions F (2, 173) = .90, p=.41, knowledge of curriculum F (2, 173) = .66, p=.52 and knowledge of assessment F (2, 173) = 1.28, p=.28. Since the results were non-significant eta squared was not reported.

Table 4.12

One Way ANOVA Results of Dimensions of Perceptions Related to PCK

		SS	*df*	*MS*	*F*	*p*
Knowledge of Inst. Strat.	Between Groups	1.32	2	.66	1.02	.36
	Within Groups	111.52	173	.65		
	Total	112.84	175			
Knowledge of Learners	Between Groups	1.69	2	.84	1.18	.31
	Within Groups	123.99	173	.72		
	Total	125.68	175			
Knowledge of Misconceptions	Between Groups	1.36	2	.68	.90	.41
	Within Groups	130.58	173	.76		
	Total	131.94	175			
Knowledge of Curriculum	Between Groups	.66	2	.33	.66	.52
	Within Groups	86.56	173	.50		
	Total	87.22	175			
Knowledge of Assessment	Between Groups	1.77	2	.88	1.28	.28
	Within Groups	119.34	173	.69		
	Total	121.11	175			

4.3. Summary of the Results

To conclude, this study aimed to examine pre service science teachers' perceptions related to science teaching in terms of their PK and PCK. Moreover, it also investigated effects of some background variables (gender and level of achievement) on their perceptions of PK and PCK.

The first question was concerned with the pre service science teachers' perceptions related to their PK. The results showed that a majority of participants perceived themselves to have "quite" knowledge in terms of PK. When the dimensions of PK were examined, it was seen that participants' perceptions of their PK level in relation to assessment was highest and classroom management was the lowest among PK's dimensions. Moreover, gender and level of achievement did not have any effect on

their perceptions of overall PK, learners & learning, lesson planning, classroom management and assessment.

The second research question investigated participants' perceptions of their PCK. The results revealed that most of the participants also felt themselves to have high level of PCK. Participants perceived their level of knowledge in terms of instructional strategies, assessment and curriculum more than knowledge of misconceptions and learners. When the effect of background variables were examined, participants' perceptions of overall PCK and its dimensions did not differ according to their gender and level of achievement.

CHAPTER V

CONCLUSIONS

This chapter includes information related to discussion of the results, implications for science education and for future research in terms of pedagogical knowledge (PK) and pedagogical content knowledge (PCK).

5.1. Discussion

The aim of the study was to investigate the pre service science teachers' perceptions related to science teaching. Within this context their perceptions related to PK and PCK were examined. Moreover, whether their perceptions differ or not according to some demographic variables (gender and level of achievement) was also explored. Participants comprised of 176 pre service science teachers from state universities of Ankara and the study was conducted in survey design. Brief summary of the study showed that pre service science teachers perceived their knowledge as adequate related to science teaching.

In order to elicit participants' perceptions, Abell's (2007) model of science teacher knowledge including both PK and PCK was used. PCK has been used as a framework in studies regarding teacher knowledge in the last decades (Abell, 2008; Aydın & Boz, 2012). To serve the purpose of the study, two instruments were used. One of them was PKST which was translated into Turkish in order to measure participants' perceptions related to PK. Exploratory factor analysis (EFA) was conducted and some of the items such as "managing co-curricular activities or showing concern for the holistic development of students" were removed. In the OECD report (2014) it was pointed out that differences between culture and education system could affect GPK; therefore, it was acceptable to eliminate some of the items after the pilot study. In addition, the other instrument that measured perceptions related to PCK was firstly developed to elicit perceptions of pre service

mathematics teachers, later some changes were made on the instrument, and confirmatory factor analysis was conducted to check the factor structure of the instrument and it was ensured that five factor structure of the instrument was also appropriate for pre service science teachers. Bukova-Güzel et. all (2013) suggested that the instrument can be applied in different contexts.

5.1.1. Perceptions of Pre Service Science Teachers Related to Their PK

Descriptive statistics were used in order to investigate the first research question. The findings revealed that pre service science teachers perceived themselves as being close to 'quite knowledgeable' in terms of PK. In other words, participants generally had positive perceptions regarding their PK. The highest mean value was observed for knowledge of assessment whereas the lowest mean value was observed in classroom management. It could be stated that participants felt themselves more competent in assessment than classroom management.

When the related studies conducted in Turkey were examined, it was seen that there were few studies directly focusing on perceptions with respect to PK of pre service teachers. However, there were studies that examined PK of pre service teachers under the title of Technological Pedagogical Content Knowledge (TPACK) framework. TPACK consisted of seven components and one of them was PK. To begin with, Savaş (2011) studied with pre service science teachers from different grade levels and regarding PK. She found that among other components of TPACK, participants' perceptions of PK had the highest with a mean value of M=4.92 and thus PK score was above the average value of the instrument. Similarly, Meriç (2014) indicated that pre service science teachers felt themselves competent with respect to PK within the framework of TPACK. This was quite consistent with the results of the current study since most of the pre service science teachers responded the items in the instrument as having "quite knowledge" and "complete knowledge". It could be implied that pre service teachers perceive themselves competent in PK. Studies conducted with pre service teachers from other departments which used TPACK framework were also examined since PK was not specific to science education. Bulut (2012) conducted a study with pre service mathematic teachers in

order to elicit participants' perceptions related to TPACK in geometry and found that they perceived their PK as high. In a similar vein, Kavanoz, Yüksel and Özcan (2015) studied with English as Foreign Language (EFL) pre service teachers by using Web-PCK framework which included five components and of these components PK had one of the highest mean values. Therefore, result of the current study showed similarities with the studies conducted in science education field and in other disciplines in terms of perceptions regarding PK. Different samples showed similar results in terms of PK.

In the present study, although classroom management had the lowest mean score among the other components, the mean value was also close to having 'quite knowledge'. The other components had mean values more than having "quite knowledge". The reason for the high perceptions pertinent to PK might be that pre service science teachers were in the last semester in their undergraduate education and they almost completed all of the content area, methods and educational sciences courses. To give an example, a study conducted by Hudson and Ginn (2007) showed that science curriculum and methods course had influence on pedagogical development of second year pre service teachers. After taking the course, participants' perceptions improved in terms of children's development, planning, implementation and theory. Therefore, why participants in this study perceived their PK as high could be explained by the courses they completed during their education. Moreover, a study carried out by Wong, Chong, Choy and Lim (2012) examined the pre service teachers' progress in their GPK throughout post graduate program. But they asserted that before starting post graduate program, participants perceived themselves as already having PK because of the courses they took at university. Conformingly, findings of the current study suggested that participants had high perceptions related to PK before they start to teach.

Furthermore, participants' perceptions of PK showed similarities and differences related to components of PK. Although components of PK may differ in different studies, they had common ones and generally measured similar constructs with varied names. In terms of assessment component, Oskay, Erdem and Yılmaz (2009)

studied with pre service chemistry teachers and found that participants could be able to use different forms of assessment while teaching science. It supported the findings of the present study because participants in this study reported that they perceived their knowledge about using appropriate assessment methods as competent. However, regarding classroom management component, although participants in Oskay, Erdem and Yılmaz's study (2009) stated that they could manage group activities, they had problems in managing unfocused, gifted and disable learners. These results were inconsistent with the present study since most of the participants indicated that their perceptions related to managing students with behavioral and learning problems were more than moderate.

Similar to present study, Okanlawon (2014) carried out a study with pre service science teachers in Nigeria context and examined their competency in terms of PK. Results indicated that participants did not feel themselves competent in terms of lesson planning, implementing and evaluating the instruction. Indeed, their perceptions were very low in these components. However, in the present study, most of the participants reported themselves as having "quite knowledge" in planning student centered lessons, planning lessons considering different needs of students, choosing suitable teaching methods, using different forms of assessment and designing assessment tools. Therefore, the results of these studies were quite different. This might be due to cultural sensitivity of PK (OECD, 2014). Also, the courses taken at university may have different contents in Nigeria and in Turkey. In Nigeria, courses in the science education department could not be sufficient for pre service teachers to develop their perceptions related to PK. On the other hand, results were consistent to some extent in classroom management component. In both of the studies, participants felt competent in using the time efficiently but in terms of dealing with learning and behavioral problems, Nigerian participants' perceptions were high compared to the participants in the present study.

Moreover, Voss, Kunter and Baumert (2011) studied with pre service secondary mathematics teachers in order to investigate their pedagogical/ psychological knowledge (PPK). The sample consisted of two group of pre service teachers. The

first group was in the theoretical phase of their education and the second group was in the practice phase. The study made a comparison between these two pre service teachers groups. In terms of classroom management, findings revealed that group scores differed significantly in favor of the group having teaching experience. Participants in the current study were about to complete the theoretical and practice courses and they gained experience during one year in their practice teaching in elementary education courses. This could be the reason why their perceptions were high with respect to classroom management which was in accordance with the findings of Voss, Kunter and Baumert's (2011) study.

In this study perceived PK of participants in terms of lesson planning was high. Participants felt that they have quite knowledge in planning lessons according to different needs of students, planning student centered lessons, and developing materials. In line with the present study, Derri, Papamitrou, Vernadakis, Koufou and Zetou (2014) suggested that practicum course that pre service teachers took during two semester had positive effects on pre service physical education teachers' lesson planning skills in Greece. Their findings showed that after taking practicum courses, participants increased their skills in lesson planning and student evaluation. Similar to the findings of present study, since all participants almost completed their teaching practice courses, it could be the reason why their perceptions related to lesson planning wash high.

5.1.2. Perceptions of Pre Service Science Teachers Related to Their PCK

The second research question focused on another type of teacher knowledge, which aimed to investigate participants' perceptions related to their PCK. Descriptive statistics were used in order to present their perceptions. Participants were asked to rate their perceived PCK on a Likert scale ranging from "never" to "always". Findings indicated that a majority of students usually perceived their level of PCK as high (M=4.07, SD=.90). When the components of the PCK were examined in detail, participants reported that they felt the most competent in knowledge of instructional strategies, curriculum and assessment. The lowest scores corresponded to knowledge of students learning and students' misconceptions. In conformance with the results of

this study, Koh, Chai and Tsai (2010) indicated that most of the participants reported their perceived PCK higher than the average.

In the literature, there are many studies studying PCK qualitatively. While some of the results of these studies supported the findings of the present study, some of them showed major differences. In the current study, regarding knowledge of science instructional strategies component, majority of the participants' perceptions in using analogies while teaching science, and making connection to daily life were quite high. Similarly, Tuzcu (2011) stated in her study that pre service science teachers reported in their lesson plans and interviews that using analogies, presentations etc. were important while teaching science which were parallel with the findings of the study. However, in practice when they were observed in classroom in Tuzcu's (2011) study, it was seen that participants did not use the previously reported strategies and preferred mainly teacher centered lessons instead and this situation was explained by the inadequacy of practicing hours. It could be said that pre service science teachers might have high perceptions related to knowledge of instructional strategies but when they were observed in real classroom, they might not reflect their knowledge into practice. Besides, there were other studies which concluded that pre service science teachers' knowledge of instructional strategies was limited (Canbazoğlu, 2008; Mıhladız & Timur, 2011) which were inconsistent with the findings of the current study.

Regarding knowledge of science learners, descriptive results revealed that most of the participants' perceptions were below the average of the overall PCK. A majority of the participants' perceptions were lower in items asking for knowing students' prior knowledge, anticipating their difficulty areas and noticing misconceptions of students in a given topic than the other items in the instrument. On the other hand, although mean score of these two components were the lowest, participants' perceived knowledge level related to knowledge of science learners was still close to high. However, findings of the current study were different from the studies that highlighted pre service science teachers had inadequate knowledge in terms of knowledge of student learning (Donnely & Hume; 2015; Ergün, 2014; Frederik, Van

der Valk, Leite & Thoren, 1999; Kaya, 2009; Uşak, 2009). The difference between these studies and the current study might be related to the fact that topic-specific nature of PCK. This study did not focused on any science topic like cell or ozone layer depletion. The instrument was in generic form; it included general statements about science teaching. Participants may responded the items related to knowledge of learner and misconceptions components by considering specific science topics that they were good at. Because teachers' level of content knowledge had influence on eliciting elementary students' misconceptions (Halim & Meerah, 2002; Kaya, 2009), they may have perceived their knowledge as high in terms of student learning and their misconceptions.

With regard to knowledge of science assessment, descriptive results indicated that a majority of the pre service science teachers perceived themselves competent in evaluating students' knowledge with a variety of ways of assessment, developing assessment tools and having enough knowledge about methods of assessment used in science education. These findings are consistent with the study of Uşak (2009). He suggested that pre service science teachers had adequate knowledge with regard to using both alternative and traditional ways of assessment while teaching. Moreover, a study conducted by Donnely and Hume (2015) confirmed that pre service science teachers could use a variety of assessment by considering the nature of the topic. Similarly, Sasmaz Oren, Ormanci and Evrekli (2011) found that pre service science teachers perceived themselves competent in applying various assessment approaches. On the other hand, there are other studies emphasizing that pre service science teachers had inadequate knowledge about different methods of assessment and prefer to use traditional methods (Canbazoğlu, 2008; Kaya, 2009; Tuzcu, 2011; Yılmaz, 2004). The inconsistence of these results might be associated with the fact that science teaching orientations of pre service teachers in this study may be different from the studies whose findings were dissimilar. As Abell (2007) mentioned, orientation held by the teacher is an important factor that influence teachers' assessment choice.

Descriptive results on knowledge of science curriculum indicated that participants perceived their knowledge of curriculum as high especially in considering the objectives of the lesson while planning the lesson, preparing a lesson plan in a given science topic and knowledge about the purposes of elementary science curriculum Although findings of Uşak's (2009) study was in line with the current study, the other studies had similarities and differences in terms of curriculum knowledge (Adadan & Öner, 2014; Kaya, 2009; Tuzcu, 2011). To illustrate, in Tuzcu's (2011) study, pre service science teachers had enough knowledge related to planning a lesson by considering the objectives which confirmed the findings of the study. As indicated before in terms of preparing lesson plans in a science topic and regarding the objectives in the program participants felt more competent. Higher perceptions of pre service science teachers' may correspond to participants' experiences in micro teaching and practice teaching course. On the other hand, Tuzcu (2011) found out that participants did not have adequate knowledge about the purposes of elementary science program as oppose to this study.

5.1.3. Perceptions of Pre Service Science Teachers' PK and PCK According to Gender

With regard to gender effect on participants' perceptions related to their PK and PCK, results of the independent samples t-test indicated that their perceptions did not differ in both PK and PCK. There were mean differences between female and male participants' perceptions but they were not significant. Moreover, no significant difference was detected according to gender regarding the components of PK and PCK. No study encountered in the literature directly concentrated on gender issues related to PK and PCK; therefore, studies within the framework of the TPACK were examined. When the relevant literature was examined, studies conducted with pre service science teachers by Koh, Chai and Tsai (2010), Lin, Tsai, Cha and Lee (2013) and Meriç (2014) supported the findings of the current study in terms of both PK and PCK. On the other hand, the findings of the study carried out by Savaş (2011) indicated that regarding PCK and PK, there were significant differences between female participants' perceptions and male participants' perceptions in favor

of female students. In relation to PK, further studies were examined within the TPACK framework since PK was not specific to science education. It was found that whereas in some studies, there was no significant difference between female and male pre service mathematic teachers' perceptions of PK (Bulut, 2012; Erdoğan & Şahin, 2010), there were some studies concluded that female participants from the department of English as a Foreign Language perceived their PK higher than the male participants (Öz, 2015; Solak & Çakır, 2014). To conclude, there were contradictions among studies from different departments and also within the same department in terms of whether perceptions related to PK and PCK differ according to gender. Lack of literature in terms of effect of gender on perceptions related to PK and PCK made comparison difficult and thus gender issues in PK and PCK need further investigation.

5.1.4. Perceptions of Pre Service Science Teachers' PK and PCK According to Level of Achievement

The other research question was related to whether participants' perceptions regarding PK and PCK differ according to their level of achievement. Level of achievement was measured by participants GPA scores at the end of the seventh semester. Results of one way ANOVA showed that there were no significant differences in their perceptions pertinent to both PK and PCK. The non-significant difference might be attributed to using overall GPA of participants which includes grades of content area courses, general culture courses and teaching profession courses. Instead of using their GPA scores, participants might be asked to write their specific course grades like classroom management, educational psychology etc. in order to investigate the effect of achievement on perceptions related to their PK. Similarly, for PCK, their grades for methods of teaching science, nature of science courses might be asked. In this manner, results on level of achievement on participants' perceptions related to PK and PCK might be significant.

5.2. Implications for Science Education

In this part of the study some of implications of for pre service science education is presented based on the results and discussion parts.

The current study aimed to present the perceptions of pre service science teachers related to science teaching descriptively. For this purpose, pre service science teachers' knowledge pertinent to their PK and PCK were examined. The results of the study suggested that pre service science teachers' perceptions are high in these two domains of teacher knowledge. In other words, a majority of the students perceived their knowledge of PK and PCK as adequate. The present study contributes to the literature by investigating pre service science teachers' perceptions regarding PK which is one of the neglected areas in research related to teacher knowledge domain. Moreover, PCK has been studied both in international and Turkish context for more than twenty years. However, as mentioned before, studies that are quantitative in nature are rare and there is a need for quantitative studies (Abell, 2008; Jüttner & Boone & Park & Neuhaus, 2013). Therefore, the study attempts to fill the gap in the literature by studying pre service science teachers' PCK quantitatively. In addition, effect of some demographic variables on participants' perceptions with respect to PK and PCK are also investigated which is also scarce in the literature. However, perceptions of PK and PCK did not differ by gender and level of achievement.

Moreover, this study has significant implications in terms of research. Perceptions of Knowledge and Skills instrument was translated into Turkish and administered to a large sample for validation in the pilot study. Exploratory factor analysis was applied and the final version of the translated instrument included four factors. Moreover, as a second instrument, Perceptions of Pre Service Mathematics Teachers Pedagogical Content Knowledge Scale, which was originally developed to be used in mathematics field, was adapted to science education. Confirmatory factor analysis was conducted in order to be sure whether its five factor structure was suitable or not for pre service science teachers. Finally, these two instruments were accepted as valid and reliable and could be used in future studies regarding PK and PCK.

Moreover, the study has implications related to practice as well. PK and PCK are crucial components of teachers' knowledge and it is important to elicit pre service teachers' perceptions related to these knowledge domains. Based on their perceptions, in what areas they need to enhance their knowledge and skills could be determined. The current study pointed out that regarding PK, pre service science teachers need to develop their knowledge of classroom management especially in terms of managing students with behavioral and learning problems, using time effectively, having coping skilss and managing discipline and stress in the classroom. Classroom management courses in faculties of education may be reviewed and in addition to delivering theoretical knowledge, participants should have the opportunity to practice what they learned as a part of the course requirements. Moreover, based on the literature (Wong, Chong, Choy & Lim, 2012), there are differences between in service and pre service teachers' knowledge in classroom management component and it could be implied that this knowledge develops with teaching experience. Therefore, teacher education programs should provide more practical experiences for pre service science teachers and more importance should be attached to mentoring of students in their practical courses in real classrooms. Practice teaching courses in science education programs could be rearranged based on the findings of the present study. Furthermore, for mentor teaachers in practice courses, traning programs might be designed since they are role models for pre service science teachers.

In addition, although participants reported that their perceptions are high related to PCK, there are some points that need to be given special attention. Based on the findings of the present study, pre service science teachers' knowledge of learners and knowledge of misconceptions need to be improved. Especially anticipating students' difiiculy areas and misconceptions, pre service science teachers had some problems. Therefore, courses in the science teacher education program like "methods of science teaching" could be revised in a way that increases pre service science teachers' awareness in terms of elementary students' misconceptions. Moreover, the results also implied that pre service science teachers perceived themselves less competent in developing various assessment tools and assessing the effectiveness of the activities.

Instructors in the education faculties might use different forms of assessment in content area and teaching profession coursers and reorganize the courses that they teach. In this way they might encourage pre service science teachers to use alternative assessment methods in their classrooms (Kaya, 2009) and provide an opportunity to observe how to apply alternative assessment methods in practice. Moreover, in order to develop overall PCK of science teachers, courses in the faculties of education should put emphasis on integrating content area and teaching profession courses. Lastly, workshops related to PCK might be organized for pre service science teachers in order to improve their PCK.

5.3. Implications for Further Research

This part includes suggestions for further studies in PK and PCK field based on the results of the current study.

Firstly, this study studied PK and PCK descriptively through survey design. However, in order to get deeper information about participants' perceptions, a variety of methods can be used like observation, lesson planning, interviews, card-sorting activities etc. Interviews and focus group study should be benefical in terms idenfiying the need areas of PK and PCK. Moreover, the findings of the present study can be used in qualitative studies since it gives an overview about pre service teachers of PK and PCK (Bukova-Güzel et. all, 2013).

In addition, since how pre service science teachers' perceptions pertinent to PK and PCK may be improved was not the focus of the study, in further studies, longitudinal designs can be employed in Turkish context. For example, the instrument might be applied before graduation, after one year in teaching and after five years in teaching which is similar to the international literature for both PK and PCK (Wong, Chong, Choy & Lim, 2012). This could help monitor the progress of the participants in both PK and PCK. Correspondingly, studies that compare pre service and in service teachers' perceptions of PK and PCK can be useful for understanding how these knowledge domains are different from or similar to each other for two groups and could be used for designing teacher professional development programs.

In this study, pre service science teachers' perceptions regarding PCK is studied quantitatively. Quantitative studies concentrating on specific science topics also need to be increased in PCK field. By developing instruments for particular science topics in order to investigate pre service science teachers' perceptions, comparisons could be done between science topics.

Except from the PCK, PK has been rarely studied in Turkish context. Therefore, studies elaborating pre service science teachers' perceptions of PK also need further investigation. Additionally, the samples of the study can include in service teachers as well as pre service teachers from different departments for comparison of their perceptions of PK.

Furthermore, pre service science teachers in Ankara were involved in the present study because of the limited time. Studies including samples from different regions of Turkey are needed in order to get a broader understanding about pre service science teachers' perceptions regarding PK and PCK. Also the effect of demographic variables on their perception is also needed to be studied with larger samples in order to increase the potential of making more precise generalizations.

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APPENDICES

A. PROGRAM OF ELEMENTARY SCIENCE EDUCATION DEPARTMENT

I. YARIYIL

	DERSİN ADI	T	U	K
A	Genel Fizik I	4	0	4
A	Genel Fizik Lab I	0	2	1
A	Genel Kimya I	4	0	4
A	Genel Kimya Lab I	0	2	1
A	Genel Matematik I	4	0	4
GK	Atatürk İlkeleri ve İnkılap Tarihi I	2	0	2
GK	Türkçe I: Yazılı Anlatım	2	0	2
MB	Eğitim Bilimine Giriş	3	0	3
TOPLAM		**19**	**4**	**21**

II. YARIYIL

	DERSİN ADI	T	U	K
A	Genel Fizik II	4	0	4
A	Genel Fizik Lab II	0	2	1
A	Genel Kimya II	4	0	4
A	Genel Kimya Lab II	0	2	1
A	Genel Matematik II	4	0	4
GK	Atatürk İlkeleri ve İnkılap Tarihi II	2	0	2
GK	Türkçe II: Sözlü Anlatım	2	0	2
MB	Eğitim Psikolojisi	3	0	3
TOPLAM		**19**	**4**	**21**

III. YARIYIL

	DERSİN ADI	T	U	K
A	Genel Biyoloji I	4	0	4
A	Genel Biyoloji Lab I	0	2	1
A	Genel Fizik III	2	0	2
A	Genel Fizik Lab. III	0	2	1
A	Genel Kimya III (Analitik Kimya)	2	2	3
GK	Bilgisayar I	2	2	3
GK	Yabancı Dil I	3	0	3
MB	Öğretim ilke ve Yöntemleri	3	0	3
TOPLAM		**16**	**8**	**20**

IV. YARIYIL

	DERSİN ADI	T	U	K
A	Genel Biyoloji II	4	0	4
A	Genel Biyoloji Lab II	0	2	1
A	Modern Fiziğe Giriş	2	0	2
A	Genel Kimya IV(Organik Kimya)	2	0	2
GK	Bilgisayar II	2	2	3
GK	Yabancı Dil II	3	0	3
GK	Seçmeli I	2	0	2
MB	Fen-Teknoloji Programı ve Planlama*	3	0	3
TOPLAM		**18**	**4**	**20**

V. YARIYIL

	DERSİN ADI	T	U	K
A	İnsan Anatomisi ve Fizyolojisi	2	0	2
A	Fizikte Özel Konular*	2	0	2
A	Kimyada Özel Konular*	2	0	2
A	İstatistik	2	0	2
A	Fen Öğretimi Lab. Uygulamaları I	2	2	3
GK	Türk Eğitim Tarihi*	2	0	2
GK	Bilimsel Araştırma Yöntemleri	2	0	2
MB	Öğretim Teknolojileri ve Materyal Tasarımı	2	2	3
TOPLAM		**16**	**4**	**18**

VI. YARIYIL

	DERSİN ADI	T	U	K
A	Genetik ve Biyoteknoloji	2	0	2
A	Bilimin Doğası ve Bilim Tarihi	3	0	3
A	Çevre Bilimi	3	0	3
A	Yer Bilimi	2	0	2
A	Fen Öğretimi Lab. Uygulamaları II	2	2	3
GK	Topluma Hizmet Uygulaması	1	2	2
MB	Özel Öğretim Yöntemleri I	2	2	3
MB	Ölçme ve Değerlendirme	3	0	3
TOPLAM		**18**	**6**	**21**

VII. YARIYIL

	DERSİN ADI	T	U	K
A	Biyolojide Özel Konular*	2	0	2
A	Evrim	2	0	2
A	Özel Öğretim Yöntemleri II	2	2	3
MB	Özel Eğitim*	2	0	2
MB	Okul Deneyimi	1	4	3
MB	Rehberlik	3	0	3
MB	Sınıf Yönetimi	2	0	2
TOPLAM		**14**	**6**	**17**

VIII. YARIYIL

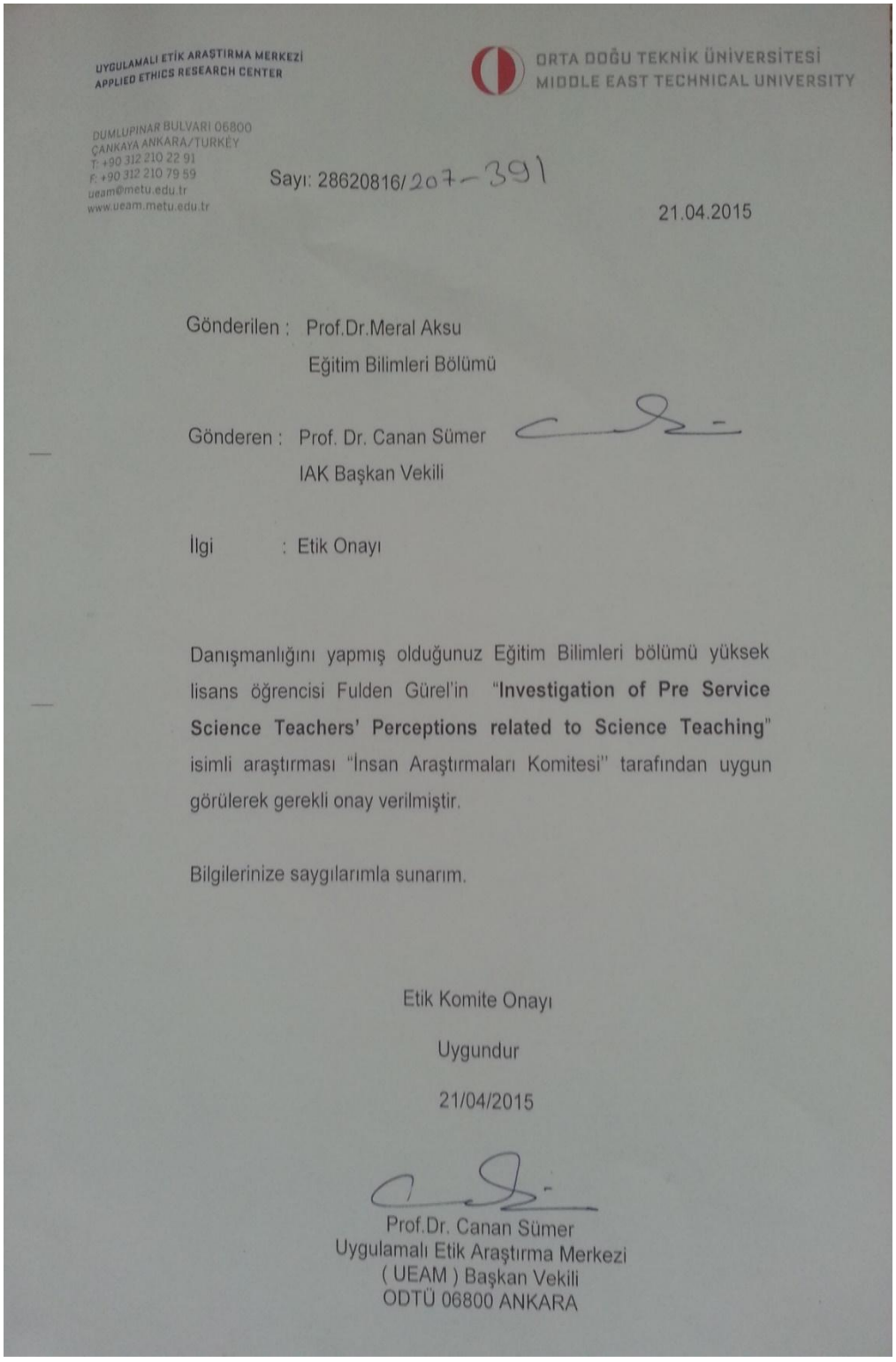
	DERSİN ADI	T	U	K
A	Astronomi	2	0	2
A	Seçmeli I	2	0	2
A	Seçmeli II	2	0	2
GK	Seçmeli II	2	0	2
MB	Öğretmenlik Uygulaması	2	6	5
MB	Türk Eğitim Sistemi ve Okul Yönetimi	2	0	2
TOPLAM		**12**	**6**	**15**

GENEL TOPLAM	**Teorik**	**Uygulama**	**Kredi**	**Saat**
	132	42	153	174

A: Alan ve alan eğitimi dersleri, **MB:** Öğretmenlik meslek bilgisi dersleri, **GK:** Genel kültür dersleri

APPENDIX B

PERMISSON FROM METU ETHICS COMMITTEE



UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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21.04.2015

Gönderilen : Prof.Dr.Meral Aksu
Eğitim Bilimleri Bölümü

Gönderen : Prof. Dr. Canan Sümer
IAK Başkan Vekili

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz Eğitim Bilimleri bölümü yüksek lisans öğrencisi Fulden Gürel'in "**Investigation of Pre Service Science Teachers' Perceptions related to Science Teaching**" isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

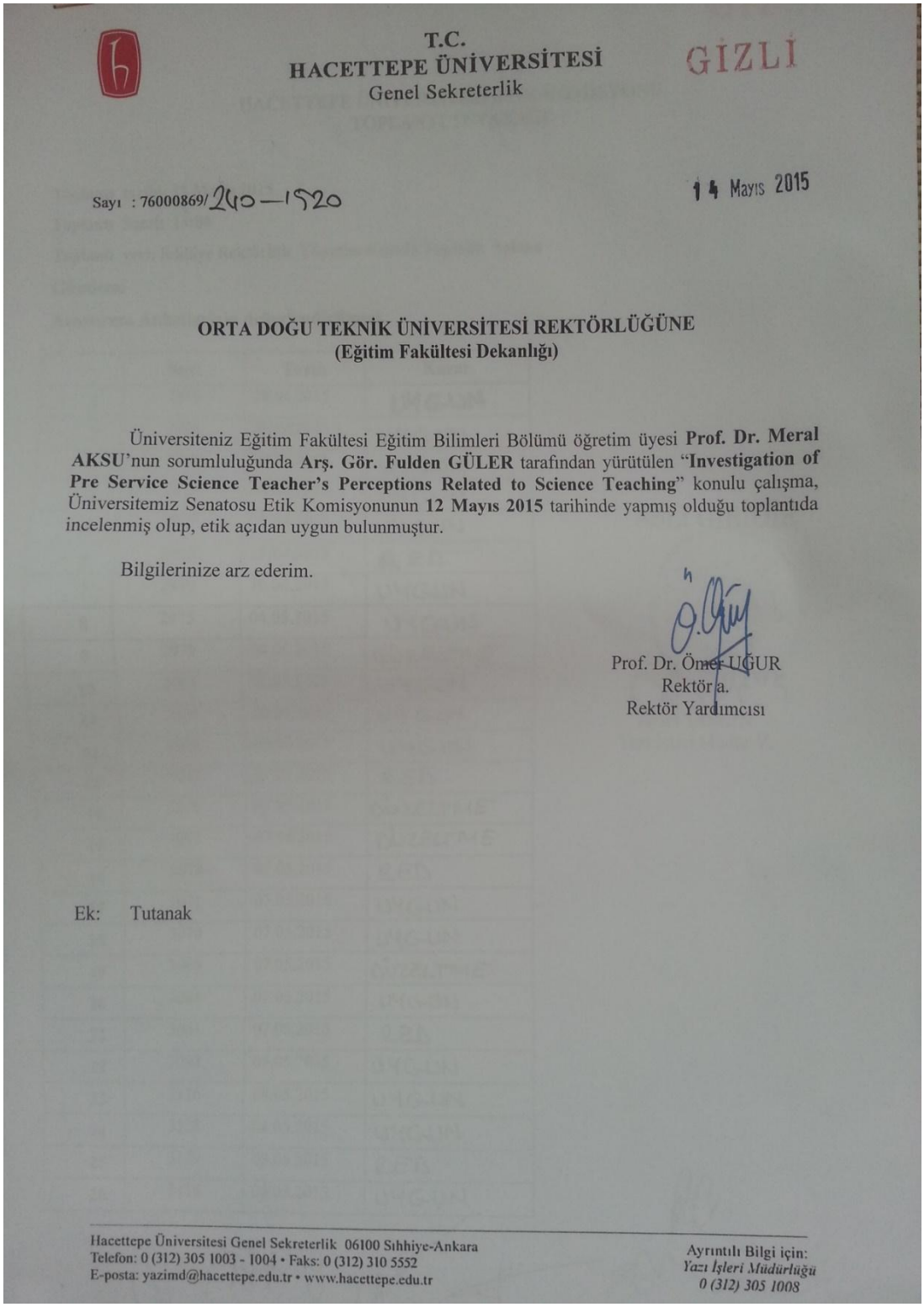
Uygundur

21/04/2015

Prof.Dr. Canan Sümer
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkan Vekili
ODTÜ 06800 ANKARA

APPENDIX C

PERMISSON FROM HACETTEPE UNIVERSITY ETHICS COMMITTEE



T.C.
HACETTEPE ÜNİVERSİTESİ
Genel Sekreterlik

GİZLİ

Sayı : 76000869/240-1520

14 Mayıs 2015

ORTA DOĞU TEKNİK ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Eğitim Fakültesi Dekanlığı)

Üniversiteniz Eğitim Fakültesi Eğitim Bilimleri Bölümü öğretim üyesi **Prof. Dr. Meral AKSU**'nun sorumluluğunda **Arş. Gör. Fulden GÜLER** tarafından yürütülen "**Investigation of Pre Service Science Teacher's Perceptions Related to Science Teaching**" konulu çalışma, Üniversitemiz Senatosu Etik Komisyonunun **12 Mayıs 2015** tarihinde yapmış olduğu toplantıda incelenmiş olup, etik açıdan uygun bulunmuştur.

Bilgilerinize arz ederim.

Prof. Dr. Ömer UĞUR
Rektör a.
Rektör Yardımcısı

Ek: Tutanak

Hacettepe Üniversitesi Genel Sekreterlik 06100 Sıhhiye-Ankara
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Ayrıntılı Bilgi için:
Yazı İşleri Müdürlüğü
0 (312) 305 1008

APPENDIX D

INFORMED CONSENT FORM

GÖNÜLLÜ KATILIM FORMU

Bu çalışma, Fulden GÜLER tarafından Ankara'da yüksek lisans tez çalışması olarak yürütülen betimsel bir araştırmadır. Çalışmanın amacı, Ankara'daki devlet üniversitelerinin fen bilgisi öğretmenliği bölümlerinin dördüncü sınıflarında okuyan öğrencilerin fen öğretimine yönelik algılarını araştırmaktır. Öğrencilerin fen öğretimine yönelik algıları pedagojik alan bilgisi ve öğretmenlik alan bilgisi olarak iki başlıkta incelenecektir. Çalışmaya katılım tamamıyla gönüllülük temelinde olmalıdır. Ankette, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Bu çalışmada sorulan sorulara cevap vermeniz yaklaşık 20 dakikanızı alacaktır. Cevaplarınız tamamıyla gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır.

Anket, genel olarak kişisel rahatsızlık verecek soruları içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda anketi uygulayan kişiye, anketi tamamlamadığınızı söylemek yeterli olacaktır. Anket sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için araştırmayı yürüten yüksek lisans öğrencisi Fulden GÜLER (Tel: 0232 311 31 59; E-posta: e161794@metu.edu.tr) ya da tez danışmanı Prof. Dr. Meral AKSU (Oda: Eğitim Fakültesi 313; Tel: 312 210 40 31; E-posta: aksume@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyad Tarih İmza Alınan Ders

----/----/-----

APPENDIX E

QUESTIONNAIRE

Değerli Öğretmen Adayları,

Fen Bilgisi öğretmen adaylarının öğretmenlik alan bilgisi ve pedagojik alan bilgilerine ilişkin algılarını incelemek için bu çalışmayı yürütmekteyim. Çalışma kapsamında görüşlerinizi anket aracılığı ile toplamak istiyorum. Bu formda 3 ana bölüm bulunmaktadır. Her alt bölümdeki yönergeleri okuyarak görüşlerinizi verilen ölçek üzerinde belirtebilirsiniz. Bu sorulara vereceğiniz yanıtlar, araştırma amacıyla kullanılacak ve gizli tutulacaktır.

Katılımınız ve katkılarınız için teşekkür ederim.

Fulden GÜLER

Orta Doğu Teknik Üniversitesi

Eğitim Bilimleri Bölümü Yüksek Lisans Öğrencisi

1. **BÖLÜM: Kişisel Bilgiler**

   Lütfen ilgili kutucuğa X işareti koyunuz ve ilgili boşluğa cevabınızı yazınız.

   1. **Cinsiyet:** ☐ Kız ☐ Erkek
   2. **Şu andaki genel not ortalamanız** (7. Dönem AGNO): _____ (örn. 3.24)
   3. **Üniversitenizin Adı:**
   4. **Sınıfınız:**
   5. **Mezun olduğunuz lise türü:**

      ☐ Anadolu Lisesi
      ☐ Anadolu Öğretmen Lisesi
      ☐ Genel Lise
      ☐ Fen Lisesi
      ☐ Sosyal Bilimler Lisesi
      ☐ Güzel Sanatlar Lisesi

☐ Spor Lisesi

☐ İmam Hatip Lisesi

☐ Özel Lise

☐ Diğer (Lütfen belirtiniz) _____

6. Mezun olduktan sonra öğretmenlik yapmayı düşünüyor musunuz?

☐ Kesinlikle düşünüyorum

☐ Düşünüyorum

☐ Başka iş fırsatlarını öğretmenliğe tercih ederim

☐ Düşünmüyorum

☐ Kesinlikle düşünmüyorum

2. BÖLÜM

Fen bilgisi öğretmen adaylarının pedagojik alan bilgilerine ilişkin aşağıda verilmiş olan ifadeleri okuyup, verilen ölçeğe göre (her zaman, genellikle, kararsızım, arada sırada, hiçbir zaman) size en uygun gelen cevabı ilgili kutuya çarpı işareti (**X**) koyarak belirtiniz.

	Hiçbir Zaman	**Arada Sırada**	**Kararsızım**	**Genellikle**	**Her Zaman**
1. Fen kavramlarını sunmak için uygun etkinlikler tasarlayabilirim					
2. Fen kavramlarını sunarken günlük yaşam ile ilişkilendirme yapabilirim					
3. Fen kavramlarını sunarken analojilerden (benzetimlerden) yararlanabilirim					
4. Bir konu ile ilgili öğrencilerin ön öğrenmelerini bilirim.					
5. Bir konu ile ilgili öğrencilerin karşılaşabilecekleri güçlükleri tahmin edebilirim					
6. Öğrencilerin bir konu ile ilgili olası kavram yanılgılarını bilirim					

	Hiçbir Zaman	Arada Sırada	Kararsızım	Genellikle	Her Zaman
7. Öğrencilerde kavram yanılgıları oluşturmayacak fen etkinlikleri hazırlayabilirim					
8. Derslerimde öğrencilerin gelişimlerine uygun örnekler seçebilirim					
9. Fen bilimleri dersi öğretim programının amaçları hakkında bilgi sahibiyim					
10. Bir fen konusuna yönelik ders planı hazırlayabilirim					
11. Derslerimi fen bilimleri dersi öğretim programının amaçları ile öğrencilerin gereksinimlerini ilişkilendirecek şekilde planlarım					
12. Derslerimin planını yaparken konunun kazanımlarını göz önüne alırım					
13. Öğretimde fen bilimleri dersi öğretim programındaki ölçme araçlarından yararlanabilirim					
14. Sınıfta uyguladığım etkinliklerin fen kavram oluşturmada ne denli etkili olduğunu ölçebilirim					
15. Ölçme ile ilgili sonuçlarımı öğretimi planlamada/düzenlemede kullanabilirim					
16. Fen bilimleri dersinde kullanılan çeşitli ölçme değerlendirme yaklaşımları hakkında bilgi sahibiyim					
17. Fen bilimleri programının içeriğine uygun, çeşitli ölçme ve değerlendirme araçları geliştirebilirim					
18. Fen bilimlerinde kullanılan farklı ölçme ve değerlendirme araçları (yazılı/sözlü sınav, ürün dosyası, poster, öz değerlendirme, vb.) ile öğrencilerimin bilgilerini değerlendirebilirim.					

3. BÖLÜM

Bu bölümde, öğretmenlik alan bilgisi ile ilgili bilgi düzeyinize yönelik ifadeler bulunmaktadır. Bu ifadeler, "hiç bilgim yok" ile "oldukça bilgim var" arasında değerlendirilmiştir. Lütfen sunulan seçeneklerden size en uygun gelen cevabı çarpı işareti (X) koyarak işaretleyiniz.

Aşağıda verilen öğretmenlik alan bilgisi konularında bilgi düzeyiniz nedir?

	Hiç bilgim yok	**Biraz bilgim var**	**Emin değilim**	**Yeterli düzeyde bilgim var**	**Oldukça bilgim var**
1. Öğrencilerin öğrenmeye karşı ilgisini geliştirme					
2. Öğrencilerin ilgisini konuya çekme					
3. Eleştirel düşünmeyi derslere uygun biçimde dahil etme					
4. Yaratıcı düşünmeyi derslere uygun biçimde dahil etme					
5. Öğrencilerde düşünmeyi kolaylaştırma ve teşvik etme					
6. Öğrenci merkezli öğretme ve öğrenme etkinlikleri kullanma					
7. Belli konular için uygun öğretim stratejilerini seçme					
8. Öğrenmeyi kolaylaştırmak için öğrencilere doğru soruları sorma					
9. Öğrencilerin farklı yeteneklerini dikkate alan dersler planlama					
10. Uygun öğretim yöntemlerini belirleme					
11. Öğrenci merkezli dersler planlama					
12. Derslerde kullanılacak öğretim materyallerini geliştirme					

	Hiç bilgim yok	Biraz bilgim var	Emin değilim	Yeterli düzeyde bilgim var	Oldukça bilgim var
13. Dersler için uygun öğretim materyalini temin etme					
14. Değerlendirme araçları tasarlama (yazılı sınavlar, sözlü sınavlar, fen uygulamaları vb.)					
15. Sınav sonuçlarına göre öğrenci performansını yorumlama					
16. Uygun değerlendirme formları kullanma					
17. Öğrencilerin başarılarını arttırmaya yardımcı olmak için dönüt/ geri bildirim verme					
18. Öğrencilerin hızına uygun öğretim yapma					
19. Öğrencilerin öğrenme güçlüklerini tespit etme					
20. Öğrencilerin bireysel öğrenmelerini etkili biçimde yönetme					
21. Uygun sınıf yönetimi tekniklerini uygulama					
22. Davranış ve öğrenme problemi olan öğrencileri yönetme					
23. Öğrenci davranışını izlemek için uygun yöntemler kullanma					
24. Sınıfta disiplini sağlama					
25. Zamanı etkili yönetme					
26. Baş etme becerilerine sahip olma					
27. Stresi yönetme					

APPENDIX F

TURKISH SUMMARY

TÜRKÇE ÖZET

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ FEN ÖĞRETİMİNE İLİŞKİN ALGILARININ İNCELENMESİ

Giriş

Dünyadaki bilimsel ve teknolojik gelişime ayak uydurmak, yenilikleri takip etmek açısından fen bilimleri önemli bir role sahiptir. Bu noktada birçok ülke fen bilgisi eğitimimin öneminin farkına varmış ve programlarında iyileştirme yapmaya başlamışlardır (ICSU, 2011). Milli Eğitim Bakanlığı (MEB) fen bilgisi dersi öğretimi programının vizyonunu "Tüm öğrencileri fen okuryazarı bireyler olarak yetiştirmek" şeklinde yapmıştır (2013, p.1).

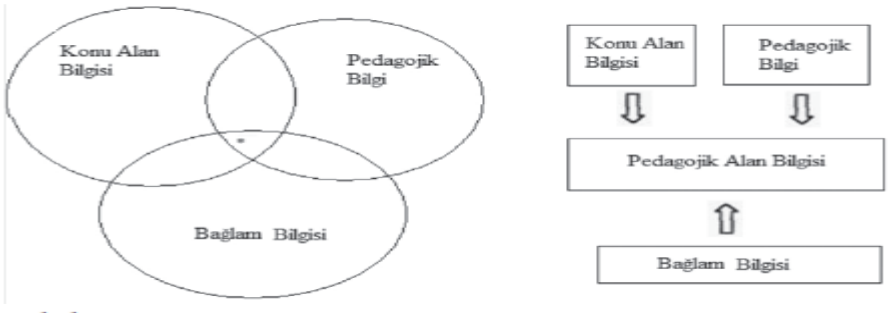
Ülkelerin eğitim sistemlerini uluslararası alanda değerlendiren ve karşılaştırma yapan araştırmalardan bir tanesi olan PISA (Program for International Student Assessment), her üç yılda bir fen, matematik ve Türkçe alanlarında öğrencilere testler uygulamaktadır. Türkiye'nin fen ve matematik alanlarındaki puanlarında artış olmasına rağmen hala OECD ortalamasının altındadır (OECD, 2013). Büyüköztürk, Çakan, Tan ve Atar (2014a) Türkiye'de TIMSS (Trends in International Mathematics and Science Study) çalışmasına katılan ilköğretim dördüncü sınıf öğrencilerinden, öğretmenleri eğitim fakültesi mezunu olan öğrencilerin, öğretmenleri eğitim fakültesinden mezun olmayan öğrencilere göre fen alanında daha başarılı olduklarını belirtmiştir. Öğretmenler öğrencilerin başarısını etkileyen önemli bir faktördür. Bu nedenle öğretmen eğitimi konusu önem verilmesi gereken bir konudur (OECD, 2011).

50 yıldan daha fazla bir süredir öğretmen eğitimi konusu birçok araştırmacı tarafından değişik şekillerde ele alınmıştır (Abell, 2007). 1987 yılında Shulman tarafından önerilen modelde öğretmenlerin pedagojik alan bilgisi, program bilgisi ve alan bilgisine sahip olması gerektiği vurgulanmıştır. Shulman'ın önerdiği modeli temel olarak, farklı öğretmen bilgisi modelleri ortaya çıkmıştır (Abell, 2007; Cochran, King, & DeRuiter, 1991). Bu çalışmada 2007 yılında Abell tarafından öne sürülen öğretmen bilgisi modeli kullanılmıştır. Bu modelde bulunan dört farklı bilgi türü şunlardır: pedagojik alan bilgisi, pedagojik bilgi, bağlam bilgisi ve konu alanı bilgisi.

Pedagojik Alan Bilgisi (PAB, öğretmenlerin sahip olduğu konu alanı bilgisi ve pedagojik bilgilerini kullanarak konuları öğrencilerin anlayabileceği şekilde öğrencilere sunmasını sağlar (Shulman, 1987). Ayrıca PAB, öğretmenleri alan uzmanlarından ayıran bir bilgi türüdür. Bir bilim insanından konunun nasıl öğretileceği konusunda bilgi sahibi olması beklenmezken, öğretmenler PAB'larını kullanarak konuyu öğrenciler için anlaşılabilir hale getirirler (Yiğit, 2009). Öğretmenin yeterli konu alanı bilgisine sahip olması konuyu öğretebileceği anlamına gelmemektedir (Ball, Thames & Phelps, 2008).

Alan yazında farklı PAB modelleri bulunmaktadır (Tamir, 1988; Grossman, 1990; Cochran, King, DeRuiter, 1991; Carlsen, 1993; Magnussoni Krajcik, Borko, 1999; Park & Oliver, 2008). Çeşitli araştırmacılar tarafından ortaya atılan bu modellerin bileşenleri de farklılık göstermektedir. Örnek olarak Tamir (1988) değerlendirme bilgisi bileşenini ilk defa öne sürerken, Magnusson, Krajcik ve Borko (1999) fen öğretimine yönelik yönelimler bileşenini modellerine ekleyerek diğer PAB bileşenlerinin üstünde olduğunu savunmuştur.

Gess-Newsome (1999) PAB modellerini bütünleştirici ve dönüştürücü olarak ikiye ayırmıştır (Şekil 1). Bütünleştirici modelde PAB, konu alan bilgisi (KAB), PB ve bağlam bilgisinin kesişim noktasındadır. Diğer yandan dönüştürücü modelde, KAB, PB ve bağlam bilgisi birleşerek yeni bir model çeşidi olan PAB'ı oluşturlar.



Şekil 1. Gess-Newsome PAB Modeli (1999)

Diğer bir bilgi türü olan pedagojik bilgi (PB) ise sınıf yönetimi, yöntem bilgisi, öğretme ve öğrenme ve eğitimin amaçları hakkında bilgiyi kapsar (Grossman, 1990; Abell, 2007). Bir başka ifadeyle PB fen ya da matematik gibi alanlara özgü olmayan tüm öğretmenlerin sahip olduğu genel bir bilgi türüdür. Morine, Dershime ve Kent (1999) etkili bir öğretim için PB'nin esas olduğunu, öğretmenlerin sınıf yönetimi, davranış ve öğrenme problemi olan öğrencileri yönetme, çeşitli öğretim yöntemlerini kullanabilme gibi konularda bilgi sahibi olması gerektiğini belirtmektedir. Ayrıca, öğretmenlerin sahip oldukları inanç, algı ve tecrübelerinin sahip oldukları PB'lerinin gelişimini etkilediğini savunmuşlardır. Tamir (1988), PB ve PAB arasındaki kesin bir ayrım olduğunu ifade etmiştir. Tamir (1988) tarafından öne sürülen modelde hem PB'nin hem de PAB'ın öğrenci, program, öğretim ve değerlendirme şeklinde dört farklı bileşeni olduğu görüşmüştür. PB'nin kapsamında bulunan öğrenci bileşeninin hiperaktif öğrencilerle nasıl ilgilenmek gerektiği bilgisi içerirken, PAB'ın bileşeni olan öğrenci boyutunda ise belirli bir konuda öğrencinin sahip olduğu kavram yanılgısını ortaya çıkarma bilgisi vardır.

Yapılan çalışmalarda PB'nin bileşenleri farklı şekillerde ele alınmıştır. Bu çalışmada PB'nin bileşenleri alan yazına paralel olarak sınıf yönetimi, öğrenci ve öğrenme, ders planlama ve değerlendirme olarak belirlenmiştir (Voss, Kunter, & Baumert, 2011; König, Blömeke, Paine, Schmidt, Hesieh, 2011).

Çalışmanın Amacı

Bu çalışmanın amacı fen bilgisi öğretmen adaylarının fen öğretimine ilişkin algılarını ortaya çıkarmaktır. Bu bağlamda, katılımcıların sahip oldukları PB ve PAB' a ilişkin

algıları incelenmiştir. Çalışmanın araştırma soruları ve bu araştırma sorularına ait olan alt sorular şu şekildedir:

1. Fen bilgisi öğretmen adaylarının sahip oldukları pedagojik bilgilerine yönelik algıları nedir?
   1.1. Fen bilgisi öğretmen adaylarının pedagojik bilgilerine ve onun bileşenlerine (öğrenme ve öğretme, ders planlama, sınıf yönetimi, değerlendirme) yönelik algıları cinsiyete göre farklılık gösterir mi?
   1.2. Fen bilgisi öğretmen adaylarının pedagojik bilgilerine ve onun bileşenlerine (öğrenme ve öğretme, ders planlama, sınıf yönetimi, değerlendirme) yönelik algıları akademik başarı durumlarına göre farklılık gösterir mi?

2. Fen bilgisi öğretmen adaylarının sahip oldukları pedagojik alan bilgilerine yönelik algıları nedir?
   2.1. Fen bilgisi öğretmen adaylarının pedagojik alan bilgilerine ve onun bileşenlerine (öğrencilerin feni anlamaların yönelik bilgi, öğrencilerin sahip olduğu fen kavramlarına ilişkin bilgi, fen programı bilgisi, fen öğretiminin değerlendirilmesi) yönelik algıları cinsiyete göre farklılık gösterir mi?
   2.2. Fen bilgisi öğretmen adaylarının pedagojik alan bilgilerine ve onun bileşenlerine (öğrencilerin feni anlamaların yönelik bilgi, öğrencilerin sahip olduğu fen kavramlarına ilişkin bilgi, fen programı bilgisi, fen öğretiminin değerlendirilmesi) yönelik algıları akademik başarı durumlarına göre farklılık gösterir mi?

Çalışmanın Önemi

Bu çalışmada öğretmen adaylarının fen öğretimine yönelik algıları PB ve PAB boyutlarında araştırılmıştır. Öncelikle, öğretmen bilgisi konusunda yapılan araştırmaların çoğu PAB ve konu alanı bilgisine (KAB) odaklanmıştır (Willson & Berne, 1999; Voss, Kunter & Baumert, 2011; König, Blömeke, Paine, Schmidt & Hsieh, 2011; OECD, 2012; König, 2013;). Bu çalışma diğer iki bilgi türünden farklı

olarak PB'ye odaklandığı için alan yazına katkı sağlayacağı beklenmektedir. Ayrıca, uluslararası alan yazın incelendiğinde PB ile ilgili yapılan çalışmaların çoğunluğu matematik öğretmen adayları ile yapılmıştır (Willson & Berne, 1999; Voss, Kunter & Baumert, 2011; König, Blömeke, Paine, Schmidt & Hsieh, 2011; OECD, 2012; König, 2013). Benzer şekilde Türkiye'de fen bilgisi öğretmen adaylarının sahip olduğu PB ile ilgili yapılan çalışmalar oldukça azdır. Alan yazında farklı alanlardan öğretmen adaylarının PB'lerinin incelenmesi gerektiği vurgulanmıştır (Voss, Kunter & Anders, 2010; Choy, Lim, Chong, Wong, 2012).

PAB yirmi yıldan fazla bir süreden beri çalışılan bir konudur ve yapılan araştırmaların büyük kısmı nitel çalışmalardır. Fakat Abell (2008) nicel ve karma desen çalışmalara ihtiyaç olduğunu da belirtmiştir. Borowski, Carlson, Fischer, Gess-Newsome, Henze, Kirschner, van Driel (2012) özellikle matematik alanında büyük ölçekli çalışmaların arttığına dikkat çekerken, Schmelzing, van Driel, Jüttner, Brandenbusch, Sandmann ve Neuhaus (2013) fen eğitimi alanında bu tür çalışmaların sınırlı olduğunu belirtmişlerdir. Bu yüzden, nicel olarak planlanan bu çalışmanın, PAB alanına katkı sağlayacağı düşünülmektedir. Buna ek olarak öğretmen adaylarının PAB algılarına ilişkin yapılan çalışmalar oldukça azdır. Öğretmen adaylarının öğrenmelerini desteklemek için algılarının belirlenmesi büyük önem taşır (Bukova-Güzel, Cantürk-Günhan, Kula, Özgür & Elçi, 2013).

Ayrıca, öğretmen adaylarının PB ve PAB'ın hangi bileşenleri konusunda kendilerini yeterli ya da yetersiz algıladıklarına bakılarak öğretmen eğitim programlarında seçmeli dersler önerilebilir. Adam ve Krockover (1997) öğretmen eğitim programlarının, öğretmen adaylarının PAB'larını geliştirecek şekilde gerekli düzenlemelerin yapılmasını önermektedir. Bu yüzden öğretmen adaylarının algılanan PB ve PAB'ları programda verilen derslerin gözden geçirilmesinde kullanılabilir.

Yöntem

Araştırma Deseni

Araştırmada tarama deseni kullanılmıştır. Tarama deseninde veriler seçilen örneklemden anket ya da görüşme formu gibi veri araçları yardımıyla toplanarak evreninin belirli özellikleri hakkında çıkarım yapmak amaçlanır (Fraenkel & Wallen, 2006). Bu çalışmada fen bilgisi öğretmen adaylarının pedagojik bilgilerine ve pedagojik alan bilgilerine ilişkin algılarını ortaya çıkarmak için anket yardımıyla veri toplanmıştır.

Çalışma Grubu

Araştırmanın evrenini Türkiye'de eğitim görmekte olan son sınıf fen bilgisi öğretmen adayları oluşturmaktadır. Ancak evrende yer alan tüm bireylere ulaşmak mümkün olmadığı için ulaşılabilir evren ile çalışılmıştır. Ankara'da fen bilgisi öğretmenliği programında eğitimine devam etmekte olan tüm dördüncü sınıf öğretmen adaylarının tamamı ulaşılabilir evren olarak tanımlanmıştır. Bu nedenle çalışmaya ODTÜ, Hacettepe Üniversitesi ve Gazi Üniversitesi'nde eğitim gören 176 katılımcı dahil olmuştur. Tablo 1'de katılımcıların üniversitelere göre dağılımları gösterilmiştir.

Tablo 1

Üniversitelere Göre Katılımcıların Dağılımı (N=176)

University	*n*	*%*
Gazi	64	36.4
Hacettepe	84	47.7
METU	28	15.9

Katılımcıların demografik bilgileri incelendiğinde, büyük çoğunluğunun kız öğrencilerden oluştuğu görülmüştür (77.3%). Liseden mezun oldukları bölümlere bakıldığında katılımcıların büyük çoğunluğunun anadolu lisesi (48.3 %), anadolu öğretmen lisesi (14.2 %) ve genel liseden (35 %) mezun oldukları belirlenmiştir. Ayrıca katılımcıların tamamına yakını (96.6 %) mezun olduktan sonra öğretmenlik

yapmak istediklerini belirtmişlerdir. Öğrencilerin bir kısmının not ortalaması 4.00 üzerinden 2.00 ile 2.99 arasında (52.3 %), bir kısmının 3.00 ile 3.49 arasında (38.6 %) ve diğer kısmınınsa (9.1%) 3.50-4.00 aralığında olduğu görülmüştür.

Veri Toplama Araçları

Çalışmada, öğrencilere iki ölçek uygulanmıştır. Bunlardan birincisi Choy, Lim, Chong ve Wong (2012) tarafından geliştirilen ve orijinalinde 38 madde bulunan "Öğretimde Bilgi ve Beceriye İlişkin Algı" ölçeğidir. Ölçeğin Türkçe uyarlaması araştırmacı tarafından yapılmıştır. Ölçek, Ege Üniversitesi Yabancı Diller Meslek Okulu'nda çalışmakta olan bir okutman ve akıcı bir şekilde İngilizce ve İspanyolca konuşabilen bir öğretmen tarafından Türkçe 'ye çevrilmiştir. Daha sonra eğitim bilimleri bölümünden iki öğretim üyesinden uzman görüşü alınmıştır. Ayrıca biri fen bilgisi öğretmeni, diğeri Türkçe öğretmeni olan iki kişi anketi incelemişlerdir. Gerekli düzeltmeler yapıldıktan sonra Ege Üniversitesi Eğitim Fakültesi'nde eğitimine devam etmekte olan 193 son sınıf öğretmen adayına anket verilerek pilot çalışması yapılmıştır. Ölçek genel pedagoji ile ilgili maddeler içerdiğinden dolayı, sınıf öğretmenliği, sosyal bilgiler öğretmenliği, Türkçe öğretmenliği ve bilgisayar ve teknoloji öğretmenliği bölümlerinden öğrencilere uygulanmıştır. Ölçekten elde edilen verilere SPSS programı yardımıyla açımlayıcı faktör analizi yapılarak ölçeğin kaç faktörden oluştuğu belirlenmiştir. Birden fazla faktörde yer alan maddeler ya da iki farklı faktöre yüklenip, faktör yükleri arasındaki değer .10'dan az olan 11 madde ölçekten çıkarılmıştır. Verilerin analizine göre ölçek orijinalinden farklı olarak 27 madde ve dört faktörden oluşmuştur. Faktörler içerdiği maddeler göz önünde bulundurularak şu şekilde isimlendirilmiştir: öğrenme ve öğrenciler, sınıf yönetimi, ders planlama ve değerlendirme. Anketin Cronbach alfa güvenirlik katsayısı. 94 bulunmuştur.

İkinci ölçek Bukova-Güzel, Cantürk-Günhan, Kula, Özgür ve Elçi (2013) tarafından matematik öğretmen adaylarının sahip oldukları PAB'larına ilişkin algılarını ortaya çıkarmak için geliştirilmiştir. Ölçek araştırmacı tarafından fen bilgisi öğretmenlerinin PAB ile ilgili algılarını ortaya çıkarmak için fen eğitimine uyarlanmıştır. Uyarlama çalışmasında ölçek sorularında geçen "matematik" kelimesi "fen" olarak

değiştirilmiştir. Ayrıca orijinal ölçekte bulunan "matematik dili ve sembolleri hakkında bilgi" faktörü, fen eğitimine uygun olmadığı için çıkarılmıştır. Bunun yerine, Abell (2007)'in fen öğretmeni bilgisi modelinde bulunan "fen öğretimini değerlendirme bilgisi" yeni bir faktör olarak ankete eklenmiştir. Uyarlanan anket, pilot çalışmada 104 dördüncü sınıf fen bilgisi öğretmen adayına uygulanmıştır. Elde edilen verilere LISREL 9.2 programı kullanılarak doğrulayıcı faktör analizi (DFA) uygulanmış ve ölçeğin 16 maddeden oluştuğu ve beş faktörlü yapısının korunduğu görülmüştür. Güvenirlik analizinde aracın Cronbach alfa katsayısı .87 olarak hesaplanmıştır.

Veri Toplama Süreci

Veri toplamaya başlamadan önce ODTÜ Uygulamalı Etik Araştırma Merkezi'ne başvurularak araçların etik açısından uygulanabilir olduğuna dair izin alınmıştır. Ayrıca Hacettepe Üniversitesi Etik Kurulu' da başvurularak gerekli izinler alınmıştır. Daha sonra öğretmen adaylarının ders programı göz önünde bulundurularak derslerin öğretim üyeleriyle iletişime geçilip anketlerin uygulanacağı gün ve saat belirlenmiştir.

Araçları tamamlama süresi yaklaşık 15-20 dakika sürmüştür. ODTÜ ve Hacettepe Üniversitesi'nde araçlar araştırmacı tarafından uygulanmıştır. Gazi Üniversitesi'nde araç fen eğitimi alanında çalışan başka bir araştırmacı tarafından katılımcılara uygulanmıştır. Araçlar uygulanmadan önce diğer araştırmacıya araç ve yönergelerle ilgili gerekli bilgiler verilmiştir. Araçların uygulama sürecince araştırmacı sınıfta bulunarak sorulan soruları yanıtlamıştır.

Veri toplama süreci üç hafta sürmüştür. Araçlar dağıtılmadan önce gönüllü katılım formu dağıtılarak çalışmanın amacı, aracı tamamlama süresi, araştırmacının iletişim bilgileri konusunda katılımcılar bilgilendirilmiştir.

Verilerin Analizi

Araçlardan elde edilen nicel veriler SPSS 20 programı kullanılarak analiz edilmiştir. Verilerin analizinde betimleyici ve çıkarımsal istatistik kullanılmıştır.

Öğrencilerin demografik bilgilerinin ortaya çıkarmak için ortalama, standart sapma, frekans ve ranj değerlerinden yararlanılmıştır. Ayrıca, fen bilgisi öğretmen adaylarının PB ve PAB hakkındaki algılarını ortaya çıkarmak için tekrar betimsel istatistik kullanılmıştır.

Katılımcıların cinsiyetinin PB ve PAB ile ilgili algıları hakkında etkisinin olup olmadığını incelemek için bağımsız örneklemler t testi uygulanmıştır. Akademik başarı durumunun etkisini inceleme için tek yönlü ANOVA kullanılmıştır. Analizler yapılmadan önce varsayımları kontrol edilmiştir.

Bulgular

Fen Bilgisi Öğretmen Adaylarının Pedagojik Bilgilerine İlişkin Algıları

Birinci araştırma sorusu fen bilgisi öğretmen adaylarının pedagojik bilgilerine (PB) ilişkin algılarını incelemeyi amaçlamıştır. Bu amaçla betimsel istatistik kullanılmış ve katılımcılardan 5 dereceli Likert ölçeğinde sahip oldukları bilgi düzeyini işaretlemeleri istenmiştir. Elde edilen yüksek ortalamalar katılımcıların sahip oldukları PB'lerini yüksek olarak algıladıkları anlamına gelmektedir. Araç için ortalama 4.14 (*SD*=.84) olarak bulunmuştur. Aracın dört boyutu için bulunan ortalama değerleri, minimum ve maksimum değerleri Tablo 2' de verilmiştir.

Tablo 2

PB'nin Bileşenlerine ait Betimsel İstatistik Sonuçları (N=176)

		SD	*Min*	*Max.*
Öğrenciler ve Öğrenme	4.16	.86	1	5
Ders Planlama	4.20	.83	1	5
Değerlendirme	4.24	.80	1	5
Sınıf Yönetimi	4.03	.88	1	5

Tablo 2'ye göre öğrenciler & öğrenme (*M*=4.16, *SD*=.86), ders planlama (*M*=4.20, *SD*=.83) ve değerlendirme (*M*=4.24, *SD*= .80) boyutlarının ortalamalarının birbirine çok yakın ve "yeterince bilgim var" düzeyine yakın olduğu görülmektedir. Ayrıca, sınıf yönetimi boyutunun ortalamasının (*M*=4.03, *SD*=. 88) diğer üç boyuttan düşüktür.

Öğrenci & öğrenme boyutundaki maddeler incelendiğinde, en yüksek ortalamaya sahip maddelerin öğrenci merkezli öğretme ve öğrenme etkinlikleri kullanma (*M*=4.37, *SD*=.86), öğrencilerin öğrenmeye karşı ilgisini geliştirme (*M*=4.26, *SD*=.76) ve öğrenmeyi kolaylaştırmak için öğrencilere doğru soruları sorma (*M*=4.20, *SD*=.88) olduğu görülmüştür. Bulgulardan yola çıkarak öğretmen adaylarının öğrenme & öğrenci boyutundaki bilgilerini "oldukça yeterli" olarak algıladıkları ortaya çıkmıştır.

Ders planlama boyutu incelendiğinde, bulguların anketin genel bulgularıyla benzerlik gösterdiği ortaya çıkmıştır. Fen bilgisi öğretmen adayları genel olarak kendilerini ders planlama konusunda yeterli olarak algılamaktadırlar. Katılımcıların büyük çoğunluğu kendilerini öğrenci merkezli dersler planlama (*M*=4.40, *SD*=.77), uygun öğretim yöntemlerini belirleme (*M*=4.23, *SD*=.81), derslerde kullanılacak öğretim materyallerini geliştirme (*M*=4.19, *SD*=.83) konusunda yeterli görmüşlerdir. Bununla birlikte dersler için uygun öğretim materyalini temin etme (*M*=4.04, *SD*=.83) ile ilgili algıları yeterli olmasında rağmen bu maddenin ortalaması bu boyuttaki diğer maddelerin ortalamasından düşüktür.

Benzer şekilde, fen bilgisi öğretmen adaylarının değerlendirme boyutu ile ilgili algılan bilgileri yüksektir. Bu bağlamda öğretmen adayları değerlendirme araçları tasarlama (*M*=4.33, *SD*=.78), sınav sonuçlarına göre öğrenci performansını yorumlama (*M*=4.24, *SD*=.77), uygun değerlendirme formları kullanma (*M*=4.18, *SD*=4.23) ve öğrencilerin başarılarını arttırmaya yardımcı olmak için dönüt/ geri bildirim verme (*M*=4.23, *SD*=.83) konularında kendilerini yeterli hissetmişlerdir.

Sınıf yönetimi boyutu, diğer boyutlarla karşılaştırıldığında en düşük ortalamaya sahip olmasına rağmen, katılımcıların büyük bir kısmı sınıf yönetimiyle ile ilgili

bilgilerini yüksek olarak algılamışlardır. Bu boyuttaki en düşük ortalamaya sahip maddeler davranış ve öğrenme problemi olan öğrencileri yönetme (*M*=3.86, *SD*=.98), sınıfta disiplini sağlama (*M*=3.95, *SD*=.90 ve zamanı etkili yönetme (*M*=3.95, *SD*=.93) şeklinde ortaya çıkmıştır.

Fen Bilgisi Öğretmen Adaylarının Pedagojik Alan Bilgilerine İlişkin Algıları

İkinci araştırma sorusu fen bilgisi öğretmen adaylarının sahip oldukları PAB'a karşı algılarını incelemektir. Yüksek ortalamaya sahip maddeler katılımcıların o konuda PAB'larını yüksek olarak algıladıkları anlamına gelmektedir. Anketin genel ortalaması 4.07 (*SD*=.90) olarak bulunmuştur. Tablo 3'de PAB'ın beş boyutuyla ilgili betimsel analiz sonuçları sunulmuştur.

Tablo 3

PAB'ın Bileşenlerine ait Betimsel İstatistik Sonuçları (N=176)

	M	*SD*	Min.	Max.
Fen Öğretim Stratejileri Bilgisi	4.15	.95	1	5
Öğrencilerin Feni Anlamalarına Yönelik Bilgi	3.98	.96	1	5
Öğrencilerin Fen Kavram Yanılgılarına İlişkin Bilgi	3.77	.97	1	5
Fen Programı Bilgisi	4.17	.89	1	5
Fen Öğretiminin Değerlendirilmesi Bilgisi	4.08	.92	1	5

Fen bilgisi öğretmen adayları, fen öğretimi stratejileri bilgisi boyutunda kendilerini yeterli olarak görmüşlerdir. Katılımcılar fen kavramlarını sunarken günlük yaşam ile ilişkilendirme (*M*=4.32, *SD*=.90) ve fen kavramlarını sunarken analojilerden (benzetimlerden) yararlanma (*M*=4.25, *SD*=.85) konularında kendilerini daha yeterli olarak algılarken fen kavramlarını sunmak için uygun etkinlikler tasarlama konusunda (*M*=3.88, *SD*=1.10) bilgilerini yeterli düzeyin altında görmüşlerdir.

Çalışmanın bulguları, katılımcıların büyük çoğunluğun PAB'ın boyutlarından biri olan öğrencilerin feni anlamalarına yönelik bilgilerini yeterli düzeye yakın olarak

belirtmişlerdir. Bir fen konusu ile ilgili öğrencilerin ön öğrenmelerini bilme (M=3.92, SD=.95) ve derslerde öğrencilerin gelişimlerine uygun örnekler seçme (M=4.03, SD=.95) maddelerinin ortalamaları genel olarak PAB'a ilişkin algılarının ortalamasının altında kaldığı belirlenmiştir.

Diğer bir boyut olan öğrencilerin fen kavram yanılgılarına ilişkin bilgileri hakkında katılımcıların algıları yeterli düzeyin altında kalmıştır. Bulgular incelendiğinde fen bilgisi öğretmen adaylarının bir konu ile ilgili öğrencilerin karşılaşabilecekleri güçlükleri tahmin etme (*M*=3.77, *SD*=.97, öğrencilerin bir fen konusunda sahip olduğu olası kavram yanılgılarını bilme (*M*=3.73, *SD*=.97) ve öğrencilerde kavram yanılgıları oluşturmayacak fen etkinlikleri hazırlayabilme (*M*=3.81, *SD*=1.00) ile ilgili konularda bilgilerine ilişkin algıları daha az yeterli şeklinde ortaya çıkmıştır.

Fen programları bilgisi boyutunun ortalaması ise katılımcıların genel olarak sahip oldukları PAB'a yönelik algılarının ortalamasından daha yüksek çıkmıştır. Öğretmen adaylarının kendilerini fen programı bilgisi ile ilgili daha yeterli gördükleri konular, derslerinin planını yaparken konunun kazanımlarını göz önüne alma (*M*=4.53, *SD*=.72), fen bilimleri dersi öğretim programının amaçları hakkında bilgi sahibi olma (*M*=4.24, *SD*=.85), bir fen konusuna yönelik ders planı hazırlayabilme (*M*=4.23, *SD*=.92) ve dersleri fen bilimleri dersi öğretim programının amaçları ile öğrencilerin gereksinimlerini ilişkilendirecek şekilde planlanlama (*M*=4.53, *SD*=.72) olarak sıralanmıştır.

PAB'ın son boyutu olarak ele alınan katılımcıların fen öğretimi bilgisinin değerlendirilmesi ile ilgili algılanan PAB'larının da yüksek olduğu görülmüştür. Elde edilen bulgulara bakıldığında yüksek ortalamaya sahip maddeler fen bilimlerinde kullanılan farklı ölçme ve değerlendirme araçları (yazılı/sözlü sınav, ürün dosyası, poster, öz değerlendirme vb.) ile öğrencilerimin bilgilerini değerlendirme (*M*=4.22, *SD*=.91) ve fen bilimleri dersinde kullanılan çeşitli ölçme değerlendirme yaklaşımları hakkında bilgi sahibi olma (*M*=4.05, *SD*=.93) şeklinde ortaya çıkmıştır.

Fen Bilgisi Öğretmen Adaylarının Pedagojik Bilgilerine ve Pedagojik Alan Bilgilerine İlişkin Algılarının Cinsiyete Göre İncelenenmesi

Çalışmanın alt problemlerinden biri olan fen bilgisi öğretmen adaylarının PB ve PAB'larına ilişkin algılarının cinsiyete göre farklılaşıp farklılaşmadığını incelemek için bağımsız örnekler t testi uygulanmıştır. Analiz sonuçlarına göre, katılımcıların sahip oldukları PB'ye ilişkin algılarının cinsiyete göre farklılaşmadığı sonucuna ulaşılmıştır, t (174) = .37, p> .05. Benzer şekilde, kız öğrencilerin PAB' a yönelik algılarının ortalaması (*M*=4.07, *SD*=.69) ile erkek öğrencilerinin algılarının ortalaması arasındaki farkın anlamlı olmadığı bulunmuştur. (*M*=4.06, *SD*=.68); *t* (174) =.03, *p*> .05). Tablo 4' de bağımsız örneklem t testinin sonuçları verilmiştir. Buna ek olarak, PB ve PAB'ın alt boyutlarına ilişkin algıların da cinsiyete göre değişmediği tespit edilmiştir.

Tablo 4

Katılımcıların PB ve PAB'a İlişkin Algılarının Cinsiyete Göre İncelenmesi

	Cinsiyet	*N*	*M*	*SD*	*t*	*p*
PB'ye İlişkin Algı	Kız	136	4.14	.65	.37	.07
	Erkek	40	4.10	.63		
PAB'a İlişkin Algı	Kız	136	4.07	.69	.030	.98
	Erkek	40	4.06	.68		

Fen Bilgisi Öğretmen Adaylarının Pedagojik Bilgilerine ve Pedagojik Alan Bilgilerine İlişkin Algılarının Akademik Başarı Durumlarına Göre İncelenmesi

İkinci alt problem olan fen bilgisi öğretmen adaylarının PB ve PAB'a ilişkin algılarının akademik başarı durumlarına göre değişip değişmediğini araştırmak için verilere tek yönlü ANOVA analizi uygulanmıştır. Akademik başarı durumları üç düzeyde ele alınmıştır. Analiz sonuçları fen bilgisi öğretmen adaylarının PB'ye yönelik algılarının akademik başarı durumuna göre değişmediğini göstermektedir, *F* (2, 173) = 1.55, *p*=.22. Aynı şekilde, öğretmen adaylarının algılanan PAB'ları üzerinde akademik başarı durumunun etkisi yoktur *F*(2, 173) = .89, *p*=.41. Sonuç

olarak, katılımcıların PB ve PAB'in boyutlarına yönelik algılarında akademik başarının bir etkisinin olmadığı sonucuna varılmıştır.

Tartışma ve Öneriler

Bu araştırmada, fen bilgisi öğretmen adaylarının pedagojik bilgilerine ve pedagojik alan bilgilerine ilişkin algıları incelenmiştir. Elde edilen bulgular değerlendirildiğinde, katılımcılar PB ve PAB konusunda kendilerini yeterli olarak algılamaktadırlar.

PB'nin bileşenleri ele alındığında, öğretmen adaylarının algıları değerlendirme boyutunda en yüksek bulunurken, sınıf yönetimi bilgisine ait algıları diğer boyutlara göre daha düşüktür. Türkiye'de, öğretmen adaylarının sahip oldukları PB'ye ilişkin algılarını inceleyen bir çalışmaya rastlanılmamıştır. Bu yüzden TPACK kavramsal çerçevesini kullanan çalışmalar incelenmiştir, çünkü TPACK'ın alt boyutlarından bir tanesi PB'dir (Mishra & Koehler, 2006). Savaş (2011) ve Meriç (2014) tarafından yürütülen çalışmalarla karşılaştırıldığında öğretmen adaylarının sahip oldukları PB'ye ilişkin algılarının yüksek olduğu tespit edilerek benzer sonuçlar elde edildiği görülmüştür. Ayrıca PB fen alanına özgü bir bilgi türü olmadığı için, farklı alanlarda TPACK kavramsal çerçevesini kullanarak yapılan diğer çalışmalar incelenmiş ve öğretmen adaylarının PB'ye dair algılarının yüksek olduğu görülmüştür (Bulut, 2012; Kavanoz, Yüksel & Özcan, 2015). Sonuç olarak çalışmalardaki öğretmen adayları farklı alanlardan olsalar da sonuçlar benzerlik göstermektedir. Bu çalışmaya son sınıf öğretmen adayları katılmış ve anketler sekizinci dönemin sonunda uygulanmıştır. Dolayısıyla öğretmen adayları alan dersleri ve öğretmenlik mesleği derslerini neredeyse tamamlamışlardır. Bu yüzden algılanan PB'lerinin yüksek çıkması bu sebeple açıklanabilir. Çalışmanın sonuçlarına paralel şekilde Voss, Kunter ve Baumert (2011) de alan derslerini ve öğretmenlik uygulaması derslerini tamamlayan öğretmen adaylarının PB'nin bileşenlerinden biri olan sınıf yönetimi ile ilgili bilgilerinin arttığı sonucuna varmıştır. PB'nin bileşenlerini içeren çalışmalar bu çalışmayla karşılaştırıldığında, bazı farklılıklar ve benzerlikler olduğu görülmüştür

(Oskay, Erdem & Yılmaz, 2009; Derri, Papamitrou, Vernadakis, Koufou & Zetou, 2014).

Diğer bir araştırma sorusu olan fen bilgisi öğretmen adaylarının sahip oldukları PAB'ları ile ilgili algılarına dair bulgular incelendiğinde, katılımcıların PAB'larını yeterli olarak gördüğü sonucuna varılmıştır. Bu araştırmanın sonuçlarına paralel olarak TPACK kavramsal çerçevesini kullanarak fen bilgisi öğretmen adaylarıyla yapılan çalışmalarda katılımcıların algılanan PAB'larının da yüksek olduğunu bulunmuştur (Koh, Chai & Tsai, 2010; Savaş, 2011)

PAB'ın bileşenleri detaylı bir şekilde incelendiğinde, çalışmaya katılan fen bilgisi öğretmen adayları, fen öğretim stratejileri bilgisi, fen öğretiminin değerlendirilmesi bilgisi ve fen programının değerlendirilmesi bilgisi bileşenleriyle ile ilgili olarak kendilerini yeterli olarak görmektedirler. Alan yazında fen bilgisi öğretmen adaylarının PAB'larını inceleyen çalışmalara bakıldığında bu çalışmanın bulgularıyla bazı benzerlikler ve temel farklılıklar olduğu görülmüştür. Özellikle PAB'ın öğrencilerin feni anlamalarına yönelik bilgi bileşeni ile ilgili bulgular oldukça farklılık göstermektedir. Bu çalışmada katılımcıların büyük çoğunluğu öğrencilerin öğrenme zorluğu yaşadığı noktaları ve sahip oldukları kavram yanılgılarını belirleme konusundaki bilgilerini yüksek olarak algılamışlardır. Fakat alan yazındaki çalışmalar fen bilgisi öğretmen adaylarının bu bileşene dair bilgilerinin yetersiz olduğunu göstermektedir (Frederik, Van der Valk, Leite & Thoren, 1999; Kaya, 2009; Uşak, 2009; Ergün, 2014; Donnely & Hume; 2015). Bu farklılığın sebebi bu çalışmada PAB'ı incelerken herhangi bir fen konusunun seçilmemesiyle açıklanabilir. Alan yazındaki çalışmalar genellikle öğretmen adaylarının zorlandığı bir fen konusuna odaklanarak katılımcıların PAB ile ilgili bilgilerini bu doğrultuda değerlendirmişlerdir. Fakat bu çalışmada katılımcılara ankette bir fen konusu seçilmeden genel olarak fen öğretimi ile ilgili maddeler verilmiştir. Bir fen konusunda öğretmenin sahip olduğu KAB düzeyi, öğrencilerin kavram yanılgılarını belirlemesini etkilediği için (Halim & Meerah, 2002), katılımcılar KAB'larını yüksek olarak algıladıkları fen konularını düşünerek anketteki maddeleri işaretlemiş

olabilirler. Bu yüzden diğer çalışmalardan farklı olarak bu bileşenle ilgili bilgilerini yüksek algılamış olabilirler.

Çalışmanın alt sorularından olan bir tanesi cinsiyetin algılanan PB ve PAB'a olan etkisini incelemeyi amaçlamıştır. Elde edilen bulgulara göre fen bilgisi öğretmen adaylarının PB ve PAB algılarında cinsiyetin etkisi yoktur. Diğer bir alt araştırma sorusu ise katılımcıların PB ve PAB algılarının akademik başarı durumuna göre değişip değişmediğini araştırmayı amaçlamıştır. Benzer şekilde, akademik başarı durumunun PB ve PAB algısı üzerinde etkisi olmadığı sonucuna varılmıştır.

Bu çalışmada fen bilgisi öğretmen adaylarının PB ve PAB'a ilişkin algıları betimsel olarak çalışılmıştır. Fakat katılımcıların sahip olduğu algıları daha detaylı incelemek için gözlem, ders planları, görüşme, kart gruplama aktivitesi gibi farklı yöntemler de kullanılmalıdır. Ayrıca, boylamasına araştırma deseni (longitidunal) kullanılarak öğretmen adaylarının mezun olmadan önce ve öğretmenlik yapmaya başladıktan sonra algıları incelenerek PB ve PAB'ın nasıl geliştiği araştırılabilir. Bununla birlikte, belirli fen konularına odaklanan PAB ölçekleri geliştirilerek, öğretmen adaylarının farklı fen konularındaki PAB algıları ve bu algıların konuya göre değişip değişmediği incelenebilir.

APPENDIX G

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü	☐
Sosyal Bilimler Enstitüsü	X
Uygulamalı Matematik Enstitüsü	☐
Enformatik Enstitüsü	☐
Deniz Bilimleri Enstitüsü	☐

YAZARIN

Soyadı : GÜLER
Adı : Fulden
Bölümü : Eğitim Bilimleri Bölümü (Eğitim Programları ve Öğretim)

TEZİN ADI (İngilizce) :

Investigation of Pre Service Science Teachers‘ Perceptions Related to Pedagogical Knowledge and Pedagogical Content Knowledge

TEZİN TÜRÜ : Yüksek Lisans [X] Doktora [ ]

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. [ ]
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. [X]

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: