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INVESTIGATION OF PRESERVICE AND INSERVICE TEACHERS' MATHEMATICS RELATED BELIEFS IN TURKEY AND THE PERCEIVED EFFECT OF MIDDLE SCHOOL MATHEMATICS EDUCATION PROGRAM AND THE SCHOOL CONTEXTS ON THESE BELIEFS

presented by

Cigdem Haser

has been accepted towards fulfillment
of the requirements for the

Ph.D. degree in Teacher Education

Major Professor's Signature

6/7/06

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By

Cigdem Haser

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ABSTRACT

INVESTIGATION OF PRESERVICE AND INSERVICE TEACHERS' MATHEMATICS RELATED BELIEFS IN TURKEY AND THE PERCEIVED EFFECT OF MIDDLE SCHOOL MATHEMATICS EDUCATION PROGRAM AND THE SCHOOL CONTEXTS ON THESE BELIEFS

By

Cigdem Haser

Teachers' beliefs have been a major focus of educational research due to their influence on teachers' practice. Understanding teachers' beliefs and the processes in which beliefs are formed provides information for teacher training programs. Therefore, teacher education programs and beginning years in teaching are investigated for their effect on the preservice and beginning teachers' beliefs.

This study explored Turkish preservice and inservice (first-year) middle school mathematics teachers' mathematics related beliefs. Preservice participants were 20 students from 2^{nd}, 3^{rd}, and 4^{th} year levels of a middle school mathematics teacher education program who were interviewed in 2004. Inservice participants were 12 first-year teachers who were interviewed both when they graduated from the same teacher education program in 2003 and after they completed first-year teaching in 2004. Additionally, a professor in the department was interviewed on his perspectives about program's impact on preservice teachers' beliefs.

Participants' beliefs were investigated in relation to the teacher education program and inservice teachers' first-year teaching experiences. A combination of three

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frameworks which categorizes the developmental levels of teachers' mathematics related beliefs was used in order to detect the belief expressions in preservice and inservice teachers' interview data.

The results indicated that teacher education program courses did not generally have a significant impact on participants' mathematics related beliefs since program courses did not attempt to change preservice teachers' beliefs. When a course was specifically designed to challenge preservice teachers' beliefs, there was some impact on mathematics related beliefs. Program courses lacked sufficient practice in which preservice teachers would implement their course experiences in the national curriculum context.

The national curriculum pace and students' differences in knowledge level were unexpected for the participants since they were not sufficiently prepared for teaching in real-classroom settings. Although inservice participants had both student-centered and teacher-centered beliefs, their teaching practices were mostly influenced by teacher-centered beliefs. The real-classroom context affected inservice participants' beliefs and practices towards teacher-centered teaching.

The study addresses the need for organization of courses that would challenge preservice teachers' beliefs, more real-classroom practice in teacher education program courses, and a better first-year mentorship policy to support beginning teachers.

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ACKNOWLEGDEMENTS

Having completed my studies at Michigan State University, I would like to express my appreciation to those who supported me during my Ph.D. and dissertation studies and made my life in East Lansing easier and enjoyable.

I would not be able to write this dissertation without constant support and encouragement of my advisor Dr. Jon Star. He challenged me to pursue better ideas, better analyses, and better writing from the very beginning. He helped me to see and follow a major idea when I was lost in some other ideas and analyses. I learned a lot from him about writing (while giving him hard time with my Turkish-English way of writing), professionalism, and academia. I am deeply grateful.

I extend my gratitude to my committee members Dr. Joan Ferrini-Mundy, Dr. Dorothea Anagnostopoulos, Dr. Sandra Crespo, and Dr. Helen Featherstone for their encouragement through the study and constant offers for help, which made me feel cared and supported. They provided me with their ideas and suggestions in our meetings and helped me to realize more similarities and differences between Turkish and the U.S. contexts. Additionally, Dr. Suzanne Wilson continuously checked me in and offered her help through my Ph.D. studies. I will miss our conversations about simply everything.

I present my sincere appreciation to all students studying in 2003 and 2004 in the Elementary Mathematics Education (EME) Program at Middle East Technical University, Ankara, Turkey. In particular, I am deeply thankful to my participants for their time and responses. Dr. Erdinç Çakıroğlu, Mine Işıksal, and Oğuzhan Doğan of EME Program helped me through the data collection process and supported me during

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The scholarship of Higher Education Council of Turkey made it possible for me to pursue my Ph.D. studies without worrying for other things.

I have also been blessed with amazing friends. Zeynep Altınsel and Mary Gebbia, made my East Lansing life peaceful and supported me with their warmth and care during my Ph.D. study. Banu has always been my smile, my other eye, my good morning, and my high spirit and Esen has always been connected to me and encouraged me during all these years. I always had a working computer because Buğra fixed it. Knowing Kristin, Lisa, Kurnia, and Marcy made my East Lansing life shiny. My friends from Turkey: Aslı, Emel, Pınar, Selen, Semra, and Şule always supported me and Asuman and Badır sent their good thoughts and energies whenever I needed. Thanks, thanks, thanks!!

My family, Nur-Tuncer-Bahar, suffered from my studies the most. My parents took a step nearly 20 years ago and sacrificed the time we would spend together for my education. I spent most of my life away from them and I also put a continent and an ocean between us, but I always felt their unconditional love and care. They all believed in me and have always been patient and encouraging. I love you all. I hope Mual and Emrahoğlu can see what they made possible. And thanks to aunts Gül and Semra for their continuous supports.

Finally, as a woman, a teacher, and a teacher educator, I am indebted to Mustafa Kemal Atatürk, the founder of Turkish Republic, for his encouragement for Turkish women and his belief in education and teachers. This dissertation is dedicated to his memory, as he addressed teachers as the only key to a nation's well being.

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CHAPTER 1

INTRODUCTION

Visible teaching, or observable practices that occur in the classroom, is partly a result of invisible processes that occur in a teacher's mental space. A teacher is likely to alter her pedagogical decisions depending on what happens in a classroom moment, what has happened before, and what she would consider as an effective next step. The perception of effectiveness of a pedagogical decision depends on how a teacher connects it to what she has experienced previously or what she anticipates from the change. The nature of previous experiences and anticipations is likely to change as the teacher becomes experienced. Teachers' thought processes, however, are not easy to observe (Clark & Peterson, 1986).

Teachers have certain ideas, expectations, attitudes, and beliefs about or towards students, teaching, learning, and the subject matter they are teaching. Among teachers' personal constructs, beliefs have been an important concern of educational research since teachers' beliefs are considered to have an impact on their practice. Teachers orchestrate multiple variables in highly complex, uncertain, and unexpected classroom environments. They manage this by using their beliefs, which are mostly formed by previous experiences (Kagan, 1992; Nespor, 1987). Since beginning teachers lack sufficient classroom experience, their beliefs become the main guide in their teaching (Feiman-Nemser, 2001) with a high possibility of limiting their choice of teaching practices and possibly their effectiveness (Cooney, 1985). Hence, beliefs play a key role in making sense of the classroom context.

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Preservice teachers' beliefs influence their interpretation of knowledge and experiences gained in teacher education programs. In other words, beliefs function as a filter for preservice teachers. Preservice teachers screen and re-organize new knowledge and experiences by using their beliefs (Kagan, 1992; Pajares, 1992). These beliefs are mostly formed during the pre-college education and are carried to teacher education programs (Lampert, 1990; Schmidt & Kennedy, 1990). To what extent these beliefs are challenged or changed through the preservice education remains an issue of concern (Wideen, Mayer-Smith, and Moon, 1998).

Understanding preservice teachers' beliefs is important in documenting the effectiveness of teacher education programs in preparing teachers. Most teacher education programs expect their students to teach differently than how they were taught, but research shows that this has not been a major achievement so far (Wideen, et al, 1998). Despite the importance of preservice teachers' beliefs in learning to teach, most research is on the inservice or student teaching experience. The absence of longitudinal research about how teachers' beliefs are formed is a critical gap in teacher education research. The evolution of teachers' beliefs and practices over time is an area to be explored in order to design and re-conceptualize teacher education programs (Kagan, 1992).

In this study, I investigated mathematics related beliefs of Turkish preservice and inservice (first-year) teachers who were in the same teacher education program. I was particularly interested in exploring their beliefs about the nature of, teaching, and learning mathematics and understanding the impact of certain previous experiences on their beliefs. I did not only focus on the teacher education program experiences, but also on the cumulative ex

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My interest in beliefs emerged early in graduate school when I began to notice differences in educational research in the U.S. and in Turkey. Unlike in the United States, educational research in Turkey has not focused on teachers' thought processes and on their beliefs extensively. While U.S. studies investigate inservice and preservice teachers' beliefs using several research traditions, Turkish studies are few in number and exclusively designed quantitatively. Moreover, there are considerable differences between the general educational system and teacher education of Turkey and the U.S. which are likely to produce different beliefs and phases of belief development or maintenance for preservice and inservice teachers.

Turkish preservice and inservice teachers' beliefs may be different when compared to U.S. teachers' beliefs. The difference could be observed mostly in the ways the beliefs are developed and centralized within the Turkish culture and the structure of the teacher education programs that does not support beginning teachers in Turkey. Turkish society values the teaching and learning of mathematics to a great degree. Mathematics-based professions, such as engineering, are highly recognized over other professions such as law. Mathematics is the key area in the national examination, the University Entrance Examination, which is required for attending at any university in Turkey (detail explanation of Turkish educational system is provided in Chapter 4). Due to the importance of the University Entrance Examination in attending a university, private services for test preparation training emerged and attending to this training have been widely considered as the only way to pass the national examination in the Turkish society. These

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society. These services are in the form of Test Preparation Centers (TPC) or private tutoring, in which many university students including preservice teachers, are involved as subject area tutors. Test training basically provides students with skills for solving multiple choice questions in limited time and reduces student involvement and the emphasis on the nature of mathematical knowledge. Mathematical knowledge is mostly illustrated as a collection of rules and shortcuts that will work for solving the questions during the test training by the instructors. Meanings of and connections among mathematical concepts are not emphasized and often ignored. Therefore, reaching a correct answer is generally seen as an indicator of learning mathematics by high school students including future preservice teachers.

Despite its high status within Turkish culture, mathematics is mostly considered as a collection of rules to be used to solve problems and this conception is emphasized especially during the examination training in TPCs or through private tutoring beginning from high school. Preservice teachers are also a part of this long enculturation process of *not thinking deeply but just solving questions correctly*, but they also continue their enculturation through tutoring in TPCs or in private settings which they consider as a valuable teaching experience before formal teaching. Therefore, it might be expected that the Turkish system not only impacts the ways preservice teachers consider mathematical knowledge and teaching and learning of mathematics, but also provides them with contexts in which they can practice the general conception of mathematics teaching in the Turkish culture.

In addition to extensive opportunities for practice of informal examination teaching before formal teaching at schools, a major difference between the U.S. and

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Turkish teachers is the lack of internship year in Turkish system. Turkish elementary teacher education programs are four-year programs with no internship year that beginning teachers are supported and monitored by collaborating teachers in their schools and the teacher education institutions, as conducted in the U.S. Therefore, they lack critical reflection from experienced teachers and teacher educators on their beliefs and practices, and they mostly tend to practice considering the national examinations and curriculum pace.

The difference between the U.S. and Turkish educational systems in terms of the conception of mathematics in the Turkish culture through national examinations and the structure of each country's teacher education process make U.S. research findings about teachers' beliefs unlikely to be generalized for the Turkish context. Hence, it seems a necessary step to gather initial data about Turkish inservice and preservice teachers' beliefs with the help of existing studies in the other contexts.

In this chapter, first, a theoretical framework for beliefs as a personal construct, their importance, and how they should be investigated will be described briefly. This section also includes some information about how I addressed certain issues in belief research in the present study. Then, the motivation for the study and the goals and outcomes of the study will be explored. Finally, a description of chapters of the dissertation will be given.

Theoretical Framework

Following arguments about the need for understanding teachers' affective and cognitive processes beginning from 1980's (e.g. Clark & Peterson, 1986), studies have been conducted to analyze teachers' knowledge and beliefs about subject matter and various comp

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various components of the teaching and learning process (Fang, 1996). Underlying these studies was a general assumption that there might be a relation between teachers' taught processes and teachers' way of teaching (Clark & Peterson, 1986). In the field of mathematics education, mathematics related beliefs are considered to be one of the key elements in the practice of teaching mathematics (Ernest, 1988). Hence, it is often claimed that investigating beliefs is a critical issue in educational research (Kagan, 1992; Pajares, 1992).

Although beliefs are considered to be important in educational research, a common framework for their investigation is lacking (Pajares, 1992). There is no consensus on the definition of beliefs in the field of education as researchers always come up with new definitions for their studies (Pajares, 1992). Even in mathematics education, researchers have different ideas about what constitutes beliefs (Furinghetti & Pehkonen, 2002). However, considering a mixed literature of anthropology and philosophy, Pajares (1992) claims there is a general agreement that beliefs are formed through enculturation and social construction. Similarly in psychology, beliefs are considered to store personal experiences and episodes of cultural or institutional transitions (Abelson, 1979) or inferences about self and contexts gathered from early experiences (Nisbett & Ross, 1980 as cited in Pajares, 1992). In the field of education, beliefs are considered to be a product of a wide array of personal experiences (Schmidt & Kennedy, 1990).

The existence of multiple belief definitions in the literature (e.g., Furinghetti & Pehkonen, 2002; Pajares, 1992; Thompson, 1992) makes it necessary to specify a definition for the concept of beliefs in this study. The notion of beliefs as formed by previous experiences underlies research about inservice and preservice teachers' beliefs.

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For example, Nespor (1987) claimed that experiences as a student impacted teachers' practices in the classroom. Similarly, teacher education research generally concluded that preservice teachers' beliefs are mostly gained during their experiences as pre-college students (Lampert, 1990; Schmidt & Kennedy, 1990). Building on this experience-driven notion of beliefs, Sigel's (1980, as cited in Pajares, 1992) definition of beliefs, which is "mental constructions of experience – often condensed and integrated into schemata or concepts" (p.351) where these constructions have a truth value and guiding function, is employed for this study. This definition allows for the framing of the relationship between preservice and inservice teachers' beliefs and their previous experiences, as well as their existing or future experiences. It also allows me to narrow down the belief literature to the studies that explicitly considered belief as an experience-driven personal construct, hence, forming a more consistent set of previous studies in order to support my results.

Nisbett and Ross (1980, as cited in Pajares, 1992) claim that prior experiences have a strong impact on final judgments, where these judgments are actually highly resistant beliefs. This implies that beliefs gained through earlier experiences are not easy to change, but those gained at the end of later experiences are perhaps more amenable to change. Pajares (1992) points that there is a need to explore the impact of early enculturation on the development of educational beliefs. Thus, I tried to see what kind of early experiences affect preservice and inservice teachers' mathematics related beliefs and what part of new experiences have less impact on those beliefs.

Studying preservice and beginning (first-year teachers) is potentially problematic because their beliefs are situated in a particular context. Teachers' range of the beliefs is limited by the

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limited by the data gathering methods, the context that the beliefs are studied, and the researchers' views about beliefs (Wideen, et al, 1998). In order to have a more accurate investigation of individuals' beliefs, Rokeach (1968) suggests three types of evidence to investigate: statements, intentions, and behaviors. In this study, I investigated preservice and inservice teachers' statements in the form of responses to my interview questions. I also asked participants about how they would respond in certain teaching scenarios, to get a sense of their intentions for different teaching situations and dilemmas. I was not able to observe their behaviors in the classroom; however, I tried to encourage them to talk about their actual practices and reasons for them.

My Motivation for the Study

The roots of this study go back in my high school education where I studied mathematics through theorems and proofs for three years with the same teacher. He used to say that he was not preparing us for the university entrance examination, but he was preparing us for the midterm examinations at the university. His teaching was direct, authoritarian, and included hardly any discussion, similar to my middle and elementary school experiences in mathematics classrooms. However, the type of mathematics we were learning was different than the mathematics taught at other high schools, a difference which revealed itself clearly when my Calculus professor in college wrote the definition of limit on the board and asked "Is there anyone who knows this definition?" This particular definition was one most applicable to several proofs. Among the freshman students in mathematics and mathematics education programs, only three students, including me, raised their hands, all from the same type of high school. This episode convinced me that I had a different view about the nature of mathematics than others. The nature of this

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nature of this difference, which was related to the idea of "proof," was something totally new for the other students.

My friends and I did not have any idea about ways of teaching and learning in mathematics other than the teacher-centered practices from our own experiences. My views about the teaching and learning of mathematics were challenged in pedagogical content knowledge courses in college, especially when my group made a presentation about co-operative learning. My views were, however, completely changed during my Masters in Mathematics Education in Turkey since I had a different role, neither a student, nor a mathematics teacher, but a teacher educator. As a graduate student, I had the opportunity to read and discuss research and I conducted an experimental study on the effect of collaborative teaching activities in a 5th grade mathematics classroom. I observed that none of the teachers in my study taught by using different teaching methods such as discovery or collaborative groups, or used different teaching materials such as hands-on manipulatives, although the school had a great mathematics laboratory.

When I became a graduate teaching assistant in Turkey, I observed that many of my students relied on study habits they had developed during university entrance examination preparation. My students, who were preservice teachers, initially believed that if they solved a lot of practice questions for an abstract algebra course instead of studying and understanding the theorems, they would pass the course. However, it turned out that solving a lot of questions was not an effective strategy in college level mathematics.

My students were challenged similar to the way I was challenged for their views about teaching and learning mathematics. In the early years of the program, they were challenged fo

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challenged for their beliefs that characterized mathematics as a set of rules and procedures and teaching and learning as a transmission process from teacher to the students. Later, as they took more courses in the program, most of them were involved in a process of change in their beliefs about the nature of, teaching, and learning mathematics towards non-traditional beliefs. From time to time, I observed them as they crafted fascinating ideas about how a mathematics classroom could look. However, these preservice teachers were challenged in a different way when they started two semesters of student teaching. I received many e-mail messages about how disappointed they were because of not being taken seriously as a student teacher for their non-traditional ideas. Thus, my students started to believe that what they had learned so far would not be useful in the classroom.

My students and I were all products of the examination-oriented national curriculum system in Turkey, which affected most of us all in similar ways during our pre-college education. Now that we are teacher candidates, teachers, or teacher educators, this system still influences us. My students had a chance to realize the nature of mathematical knowledge and how it should be studied, taught, and learned during their studies in the teacher education program. However, the impact of their training might be less than expected. Four-year teacher education programs try to bring teacher candidates to a world of mathematics education which they have never experienced as a student, after 11 years of experience where they were taught in highly traditional ways. At the end of their training in teacher education programs, we send our students back to their old planet as a teacher with expectations that they will change their old practices. We generally do n

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generally do not hear from them anymore. The effectiveness of our teacher education program on teacher candidates' beliefs and practices remains uninvestigated.

In this study, I wanted to explore the effectiveness of teacher education programs in Turkey in the area of mathematics related beliefs. I wanted to have an idea about how experiences our students had in the past and in the teacher education program related to their beliefs. Unfortunately, Turkish high school students do not generally know what they will study in college due to the national examination system. High school students in Turkey rank college-major pairs and they are placed in one of these pairs based on their examination scores. Hence, reaching teacher candidates during their high-school education is almost impossible. So I could not focus on pre-college experiences of preservice teachers, but I was able to focus on their experiences in the teacher education program and gather their reflections on the pre-college experiences.

Another major motivation for me was my future status after I complete my doctoral studies. Since I am going to be a member of the faculty in the same department where I worked before, I conducted this research to help me formulate my ideas about how our program should be improved and which necessary steps should be taken in order to challenge our students' mathematics related beliefs. By analyzing factors impacting their beliefs, I am hoping to target my students' beliefs in a better way in my courses.

Goals and Outcomes of the Study

Driven by the literature and my personal motivation, I investigated preservice and inservice (first-year) middle school mathematics teachers' beliefs about the nature of, teaching, and learning mathematics. In particular, I tried to determine how the Elementary Mathematics Education program affects preservice and inservice (first-year) middle schoo

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middle school mathematics teachers' beliefs about the nature, teaching, and learning of mathematics. The primary outcomes of the study are the current beliefs of preservice middle school mathematics teachers studying in or graduated from the Elementary Mathematics Education program, the effectiveness of certain courses on participants' mathematics related beliefs, and the impact of the first year of teaching on program graduates' beliefs. Suggestions for the future practices of mathematics teacher education in Turkey as well as future research paths will be an additional outcome of this study.

The dissertation is composed of eight chapters. In Chapter 2, I combine the literature about the beliefs generally and preservice and inservice teachers' mathematics related beliefs, and document the need for this research in the field of education. Chapter 3 describes three frameworks which help in analyzing mathematics related beliefs of preservice and inservice teachers and how I combined these three frameworks into one in order to analyze the data of this study. The methodology used in the study, with descriptions of the participants, contexts, instruments, and the procedures are given in detail in Chapter 4. Chapter 5 reports preservice teachers' mathematics related beliefs and how the teacher education program impacted on their beliefs. In Chapter 6, inservice teachers' mathematics related beliefs are described in detail while the factors influencing their beliefs are described in Chapter 7. The discussion of the findings and the conclusions of the study are presented in Chapter 8.

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CHAPTER 2

LITERATURE REVIEW

In this study, preservice and inservice (first-year) middle school mathematics teachers' mathematics related beliefs are explored and the possible impact of preservice and first-year experiences are investigated. The study is derived from research on teachers' mathematics related beliefs, mathematics teacher education, and experiences of beginning teachers. I narrow the literature review to the specific goals of the study in order to provide major topics and important findings of research in the field. In particular, I document (i) the importance and characteristics of teachers' beliefs and mathematics related beliefs, (ii) the impact of teacher education programs on preservice teachers' beliefs in general and mathematics related beliefs in particular, and (iii) the influence of first-year experiences on beginning teachers' general teaching and learning beliefs and specifically mathematics related beliefs.

There are different traditions in belief research. Although most studies investigate beliefs through interviews about and observations of teaching, surveys are also employed and written works are analyzed. In some of the studies, not only preservice or inservice teachers are considered as participants, but also administrators and students are involved. I describe data collection methods and instruments of the studies briefly in order to provide better information about how the results are reached.

Research documents the nature and function of teachers' beliefs and emphasizes their importance in the classroom. Specifically, teachers of all grade levels hold certain beliefs about mathematics and its teaching and learning. These beliefs are influenced by certain educa

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certain educational experiences that the teachers have been through, such as pre-college education, teacher education programs, teaching experiences in the classroom, and teacher development programs. Since my focus is on pre- and inservice (first-year) teachers' beliefs in relation to a specific teacher education program and the first year of teaching experience, I will document studies conducted during the teacher education program and initial teaching years.

One of the major areas of belief study is concerned with the impact of students' beliefs on their learning and the relationship between teachers' beliefs and students' beliefs. Students' beliefs about mathematics are considered to be the collection of their beliefs about the classroom context, the self, and the ways they believe mathematics education should be, and the nature, justification, sources, and acquisition of mathematical knowledge in recent reviews (Muis, 2004; Op't Eynde, de Corte, & Verschaffel, 2002). Typically, elementary and secondary students believe that mathematics is composed of basic arithmetic calculation and application of rules, which cannot be learned alone and need confirmation from an authority (Lampert, 1990; Stodolsky, Salk, & Glaessner, 1991). Students' mathematics related beliefs are mostly influenced by their teachers' beliefs and practices (Carter & Norwood, 1997) and beliefs are considered to have an impact on the way students learn mathematics, problem solving, as well as on their motivation in the mathematics classroom (Kloosterman, 2002).

The relationship between teachers' beliefs and students' learning has multiple non-linear aspects. Teachers hold several beliefs about the nature of the subject matter, teaching, and learning. They have certain beliefs about how students learn the subject

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matter, how instruction in the classroom should occur, and how a teacher should interact with the students in the classroom (Borko & Putnam, 1996; Thompson, 1992). These beliefs influence teachers' practices. For example, in Thompson's (1984) study of teachers with different mathematical beliefs, the teacher with more traditional view of mathematics taught mathematics in more traditional ways whereas teachers with non-traditional beliefs about mathematics emphasized the connected nature of mathematical knowledge and tried to engage students in knowledge generation through several teaching and learning activities. Similarly, teacher's beliefs about students and how students learn impact their teaching preferences and their communication with the students (Calderhead, 1996). Therefore, teachers' beliefs impact the way they consider instruction in the classroom, which influences the way students learn and how they consider instruction. Teachers' beliefs also influence the ways they interpret experiences with students in the classroom (Thompson, 1992). Although many studies address the importance of investigating students' beliefs and their relation to teachers' beliefs, these areas will not be explored here in order to focus on the preservice and beginning mathematics teachers' beliefs.

Several different beliefs such as beliefs about self-efficacy and self-esteem, epistemological beliefs, and the beliefs about teaching and learning in the content area, have been investigated in the field of education at different levels such as elementary schooling and higher education, with different populations such as students, teachers, and university professors. The present study is concerned with preservice and first-year teachers' beliefs about the nature of, teaching, and learning mathematics. Thus, in this chapter, I will review research on preservice and beginning teachers' teaching and learning beliefs, a

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learning beliefs, and mathematics related beliefs with respect to impacts of preservice education and initial years in the field. I borrow the term "beginning teacher" from Veenman (1984) which he uses to refer to teachers in their first three years, in order to address first-year inservice teachers. Although this study is about middle school mathematics teachers and their beliefs, I will be referring to and discussing elementary teachers, secondary teachers, and the general impact of teacher education programs and first-year teaching on teaching and learning beliefs in order to provide a broad perspective.

The notion and the definition of beliefs (experience-driven constructs) was presented in the previous chapter. Hence, I continue with specifying teacher's beliefs, their characteristics, and importance. Then, I review the studies that document the impact of teacher education programs on preservice teachers' and preservice mathematics teachers' general teaching and learning beliefs and on their beliefs about the nature of, teaching, and learning mathematics. A review of how these beliefs are influenced by experiences in the early years of teaching follows. While documenting preservice and beginning teachers' beliefs, I initially present the general findings of research reviews. Then, I describe several studies in different contexts, with different interventions, or different groups of participants. Finally, I summarize and discuss the literature separately for preservice and beginning teachers, and address important research points or implications for teacher education based on the studies reviewed.

Teachers' Beliefs

Understanding the mental mechanisms behind teachers' actions in the classroom has been a challenging topic in educational research. The challenge emerges as a result of the nature of sev

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the nature of several interrelated personal constructs impacting teachers' behaviors, such as beliefs, attitudes, conceptions, emotions, and values. Among them, beliefs are not easily observed or detected. Two teachers having the same teaching are likely to have different beliefs underlying that teaching (Kagan, 1992).

Besides lacking sufficient observable indicators, beliefs do not have definitions that people agree on, even when mathematics related beliefs are considered (Furinghetti & Pehkonen, 2002). Moreover, the lines that distinguish beliefs from other personal constructs are not well-defined. For example, while some researchers claim that conceptions include beliefs (e.g., Thompson, 1992), other researchers consider conceptions as a part of beliefs (e.g., Ernest, 1989). Given the complicated nature of beliefs, investigating teachers' beliefs and their relation to teaching in the classrooms has always been a challenge for educational researchers.

Characteristics of Teachers' Beliefs

Understanding teachers' beliefs is difficult because beliefs do not reveal themselves easily. Rokeach (1968) claims that even when a person says that he or she believes something, "he may or may not be representing accurately what he truly believes because there are often compelling personal and social reasons, conscious and unconscious, why he will not or cannot tell us" (p.2). Being in a complicated social context of classroom, fellow teachers, and school, teachers may not claim what their actual beliefs are. Although a single belief may not be identified easily, a collection of beliefs is more likely to be detectable. This collection is often named as "belief system."

Belief systems can be considered as cognitive structures and be characterized as dynamic and subject to restructuring when individuals evaluate their beliefs depending on their experiences (Thompson, 1992). Green (1971) identifies three dimensions of belief systems depending on the relation of beliefs within the system. The first dimension is that a belief is not independent of other beliefs and there is a quasi-logical structure in which some beliefs are related to others with a relationship similar to that of reasons and conclusions. There are "primary" beliefs, such as a teacher's beliefs about the importance of clarity in presenting mathematics to the students, and "derivative" beliefs, such as a teacher's beliefs about the importance of preparing lesson clearly and being ready to answer the possible questions that students might ask. The second dimension is that beliefs might vary in their degree of conviction with the other beliefs that are held in the system. "Central" beliefs are the most strongly held ones where "peripheral" beliefs are the ones that are most open to any change or examination. Green notes that beliefs may be logically derivative, yet psychologically central. The third dimension is related to the nature of the system: that beliefs are held in clusters and these clusters mostly exist in isolation from each other. Clustered nature of beliefs makes it possible for one to hold conflicting sets of beliefs. Ambrose (2004) gives an example of belief clusters of creativity and mathematics. While a teacher may believe that students should be given opportunities to be creative, he/she may connect this belief to his/her beliefs about art and writing, but not to his/her beliefs about mathematics. Having creativity opportunities in art and writing during childhood, but lacking similar experience in mathematics may be effective in forming these clusters.

Similarly, Rokeach (1968) claims three assumptions about belief systems parallel to Green's (1971) identifications. In addition to identifying the importance of beliefs within a belief system as central and peripheral, he describes more central beliefs as resistant to change. When a more central belief is changed, the impact will be wide in the rest of the system, but a change in a peripheral belief will not impact the whole belief system.

Since the nature of beliefs is necessarily subjective, beliefs and belief systems are often considered different than knowledge and knowledge systems. Thompson (1992) provides several distinctive features of beliefs and knowledge that are most relevant to studying teachers' beliefs depending on wide array of literature. She argues that beliefs can have varying degrees of certainty. Although there are contradictory issues among beliefs that people hold, knowledge is true and certain. Evaluation and judgment of knowledge require certain norms of evidence and inquiry. However, beliefs lack such evidence for their evaluation and also they often lack agreed upon criteria on which beliefs can be evaluated or judged. These characteristics are parallel to what Abelson (1979) addresses as distinguishing features of belief systems.

Pajares (1992) summarizes the function of beliefs at the end of his review about teachers' beliefs. Three important and related functions of beliefs seem to emerge from the review. First, beliefs filter new information and experience due to their affective, evaluative, and episodic nature (Abelson, 1979). Existing beliefs organize and define new information gathered through learning and inquiry. Similarly, beliefs systems serve as a base to recognize, categorize, and organize new experiences (Schiebe, 1970). Although beliefs may be helpful in the organization of new experiences, they are mostly considered as limiting factors, especially in teacher education. Second, epistemological beliefs influence knowledge interpretation because they define, select, and filter cognitive processes. Nespor (1987) claims that the ways domain specific knowledge is possessed

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and recalled for reconstruction are influenced by beliefs. Third, beliefs impact behavior and perception but they also might misguide them. They help teachers in dealing with complex situations in schools, and they aid in simplifying classroom life, identifying goals, and directing them in particular problem situations. However, these beliefs may not have clear logical relevance to real-world situations (Nespor, 1987).

Research indicates that teachers have several interconnected beliefs about the subject matter they teach, how they should be teaching it, how it is learned, roles of teachers and students in the teaching and learning process, and other educational issues such as school contexts and general goals of education (Putnam, Heaton, Prawat & Remillard, 1992). Since beliefs are experience-driven mental constructs, experiences with the subject area, previous teachers, and students during their pre-college, preservice, and inservice years are considered to impact their beliefs. Teachers use these beliefs while organizing their practices. What teachers believe about the nature of knowledge, skills, and reasoning in a content area affects the way they determine the concepts to be taught. The way teachers teach the concepts is influenced by how they believe teaching should occur in the classrooms. And finally, teachers' beliefs about ways of learning concepts in a particular content area impact the learning activities they design for students. Thus, having been influenced by their beliefs, teachers' practices affect the way students experience the content area, develop an idea about teaching, and what and how they learn. These experiences influence their students' beliefs.

The complicated chain reaction of "teachers' beliefs impacting their practices which influence students' beliefs" becomes a circle when preservice teachers start the teacher education programs bringing their beliefs from pre-college years. Educational research focused

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research focused on each of the links in this circle in order to explain the complex nature of teaching and learning in classrooms. Research showed that each link is not composed of a simple cause and effect relationship, but of several factors and contexts interacting in complex ways (Raymond, 1998). How preservice teachers' beliefs, which are mostly maintained from pre-college education, impact the extent they benefit from the teacher education program experiences and how beginning teachers' practices in the classroom are influenced by their preservice beliefs, experiences, and the contextual factors will be reviewed here mostly in the field of mathematics education.

Preservice Teachers' Beliefs: The Impact of Teacher Education

Preservice teachers come to teacher education programs with certain beliefs about mathematics and its teaching and learning (Cooney, 1999). They generally believe mathematics to be a static body of knowledge, which is learned by memorizing facts, principles, formulas, and procedures from a teacher who demonstrates them and controls their correctness (Wilcox, Lanier, Schram, & Lappan, 1992). A closer analysis shows that assumptions about knowing mathematics in most classrooms are shaped by pre-college experiences "in which *doing* mathematics means following the rules laid down by the teacher; *knowing* mathematics means remembering and applying the correct rule when the teacher asks a question; and mathematical *truth is determined* when the answer is ratified by the teacher" (Lampert, 1990, p.32, italics in original). For example, preservice teachers from both elementary and secondary majors generally believe that to know something in mathematics means to remember rules and to use the standard procedures without difficulty (Ball, 1990).

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Wideen et al. (1998) claim that "the story of how beginning teachers experience programs of teacher education begins with who they are and what beliefs they bring to preservice teacher education" (p.141). Preservice teachers' experiences in the teacher education programs are filtered and shaped by their existing beliefs (Pajares, 1992), mostly causing less impact of these programs on the preservice teachers than expected (Nespor, 1987). Commenting on Schutz's (1970) work on professions such as medicine and law whose students are almost new to the medicine and law teaching contexts, Pajares (1992) claims that preservice teachers are insiders in teacher education and they do not need to reformulate the context of teacher education as a new student. They are not shocked by the people, classroom, and practices in the teacher education programs and they do not tend to change their beliefs despite the (relatively) new information and experiences.

There are conflicting views on whether preservice teachers' beliefs can be changed or not since beliefs are resistant to change (Kagan, 1992). The impact of teacher education program experiences such as a course or a series of courses (e.g. educational psychology, methods of teaching mathematics) and student teaching on preservice teachers' beliefs have been investigated in different content areas. Some experiences are found to be effective especially when they target preservice teachers' beliefs. However, some courses do not result in change in beliefs in the way or extent that researchers expect, even when the courses are designed specifically to change the beliefs. Examples of studies with different levels of impact are given here.

Change in preservice elementary teachers' beliefs about pedagogical and mathematical content knowledge and whether these beliefs influenced their instructional practices were investigated by Foss and Kleinsasser (1996). In a 16-week mathematics methods course including teaching three lessons in primary schools, 22 preservice elementary teachers and the instructor of the course were observed in the course. They were interviewed in the beginning, middle, and end of the course, and were administered surveys to investigate their mathematics related beliefs. The course, which was based on constructivism and discovery, was not designed by the researchers but it was observed for its impact on the beliefs. The study showed that the preservice teachers' beliefs about mathematical knowledge did not change through the course. Preservice teachers mostly mentioned computation, solving problems, manipulation of numbers, theories, and equations depending on their personal history and beliefs, but not reasoning and creativity which were emphasized in the course. Preservice teachers characterized good mathematics teachers as providing fun and enjoyment in the classroom while decreasing students' mathematics anxiety and promoting learning. Preservice elementary teachers in this study mostly disregarded their methods course experiences and described their future teaching as a collection of drill and memorization with limited use of textbooks and worksheets where they would build concrete relationships to daily life. They would employ group work from time to time, but mostly would depend on what they had experienced and observed as a student in pre-college education. They believed that students could learn mathematics when they had a certain type of mind.

As a result of their study, Foss and Kleinsasser (1996) claimed that it would be difficult to change preservice elementary teachers' beliefs about pedagogical and content knowledge of mathematics by a methods course. Preservice teachers still relied on their prior beliefs and personal experiences while formulating their new experiences in the teacher educatic

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teacher education program. They concluded that preservice teachers' mathematics related beliefs affected their teaching practice but did not promote it. They suggested that teacher education and mathematics teaching research should consider moving preservice teachers' mathematics related beliefs to a conscious level.

How preservice teachers' beliefs would change in an introductory teacher education course which was designed to make preservice teachers examine and reflect on their own beliefs, was investigated by Anderson and Bird (1995). They conducted interviews in the beginning and end of the semester and analysis of written responses to the tasks and video cases (teaching writing, social studies, and mathematics) presented in the course. Among 31 students in the class, the researchers presented the case of three students whom they believed represented the beliefs of the rest of the participants. Even when an unfamiliar "eye-opening" video case was presented to preservice teachers, they mostly interpreted it within their beliefs about teaching so that the case did not look unfamiliar. They filtered the ideas presented in video cases and related papers through their beliefs. Preservice teachers in this study extracted what they expected to see from these examples instead of reflecting on own teaching beliefs through them. The researchers argued for the need for pedagogical content knowledge of teacher education where teacher educators should consider the interaction between the individual student and specific materials and activities of teacher education. They concluded that when teacher educators decide to use video cases in order to help preservice teachers examine their beliefs, they should consider (i) the history of the cases, emphasizing their difference from traditional cases; (ii) accompanying texts and assignments in which preservice teach

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Joram and Gabriele (1998) describe an educational psychology course which targeted preservice teachers' beliefs and had an impact on them. The researchers first identified a total of four beliefs about teacher education experiences, teaching, and learning: (i) teacher education courses would not be that relevant when compared to the experience in the field; (ii) teaching could be learned by considering past teachers as a model; (iii) teaching and learning in the classroom would not be a problem; and (iv) students would learn easily when classroom management would maintained. Then, they used metaphors and analogies in order to target these beliefs. The researchers implemented a survey with some open-ended questions both in the beginning and at the end of the course to a total of 53 students. Moreover, they asked the preservice teachers whether their beliefs about teaching and learning had changed since the beginning of the course. Results showed that when preservice teachers felt a change in their beliefs, they actually had a change. Thus, the course designed to target preservice teachers' beliefs had some impact on their beliefs. They concluded that preservice teachers' beliefs should be targeted throughout the program courses so that further changes would occur with more students and greater impact.

Most recently, a similar intervention that targeted preservice elementary teachers' epistemological beliefs about mathematics, and teaching and learning in mathematics was conducted by Gill, Ashton, and Algina (2004) in order to investigate effective ways of instruction that influenced beliefs. The researchers prepared a total of eight mathematics teaching scenarios, four representing constructivist teaching and the other four representing procedural teaching, in order to understand preservice teachers' implicit (not depending on self-reports) epistemological mathematics beliefs. They used these texts for the experimental group and asked the preservice teachers to rate the excellence of teaching, while they implemented the traditional texts for the control group in a child development course. A total of 161 preservice teachers attended to the course. They also implemented an epistemological mathematic beliefs survey and a general epistemological survey to both experimental and control groups to investigate their explicit (relying on self-report) beliefs. At the end of their intervention in which they activated and challenged beliefs, the researchers were able to increase preservice teachers' awareness of their epistemological beliefs. The logical counter-arguments they proposed to preservice teachers' beliefs persuaded a change in those beliefs, consistent with the goal of the intervention. The researchers concluded that the general epistemological beliefs might be a good place to start to develop the type of mathematics related beliefs that teacher educators would like to promote.

Many studies report no change in preservice teachers' beliefs because most of the study participants did not change these beliefs. Nettle (1998) claimed that when there seemed to be no impact of teacher education programs on preservice teachers' beliefs, there was actually some impact which was often underestimated. Nettle investigated the stability and change in 79 preservice elementary teachers' beliefs about teaching in relation to a 3-week period of student teaching. Comparison of pre- and post-questionnaires showed that majority of participants maintained their beliefs about teaching after practice teaching, most probably due to the impact of their prior beliefs. However, there were changes in some of the participants' beliefs. The change occurred in preservice teac

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preservice teachers' beliefs, as affective oriented teaching (such as prioritizing motivation and interpersonal relations in learning) moved towards more task oriented teaching (such as prioritizing students' active involvement and structuring of learning to complete a task). Nettle discusses that instead of interpreting the stability as an indication of the ineffectiveness of teacher education programs, considering it as a part of the process of development of preservice teachers' beliefs would be a better approach in research.

Ambrose (2004) and her research team investigated the impact of early experience on preservice teachers' beliefs. They identified several beliefs that they hoped preservice teachers would develop and conducted an experimental methods course in addition to a content course in which 15 preservice teachers attended and worked in pairs closely with elementary school students. The results of interviews, surveys, preservice teachers' written works and field notes showed that the intense experience of teaching mathematics to an elementary school student and reflection on this practice was partly successful in helping preservice teachers to develop new beliefs. Yet, most of the preservice teachers maintained their beliefs that teaching mathematics is explaining everything to the students instead of giving them opportunity to think. Preservice teachers also believed that mathematics learning would be attainment of symbolic procedures. Ambrose concluded that preservice teachers maintain their prior beliefs while forming the new ones. Depending on the effectiveness of the teacher education experiences, these prior beliefs might become less central as preservice teachers progress through the program. The key to effectiveness, in this case, was the intense experience with elementary school students accompanied by reflection.

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In the six studies described in detail above, the first three studies (in the order they appear: Foss & Kleinsasser, 1996; Anderson & Bird, 1995; Joram & Gabriele, 1998; Gill, et al, 2004) investigated the impact of a single course over one semester. Nettle (1998) investigated the impact of 3 weeks of practice teaching on preservice teachers' beliefs while Ambrose (2004) conducted a semester-long course in which preservice teachers integrated a content area course and intense teaching practice. Although these interventions were carefully designed, even the semester-long course is a relatively short time period, compared to the 4 or 5 year period of teacher education programs.

Single course interventions might be found to be successful in changing preservice teachers' beliefs, but what part of changed beliefs is maintained at the end of the teacher education programs and carried to the initial years of teaching is rarely addressed in belief studies. Research indicates that inservice teachers generally depend on their pre-college content knowledge and beliefs in the first few years of real-classroom teaching (Feiman-Nemser, 2001), where their beliefs are likely to limit their classroom practice (Cooney, 1985). Hence, the impact of interventions on preservice teachers' beliefs might not be long enough to serve them through their initial years in teaching.

In order to have better and longer impact on preservice teachers' beliefs, interventions should be consistent through the program courses, as Joram and Gabriele (1998) claim. However, they also address two related factors that underlie the difficulty in changing preservice teachers' beliefs about teaching and learning through teacher education programs. First, preservice teachers' beliefs are reinforced through observing other teachers and their own teaching experiences. Practices that might challenge their beliefs are mostly not present in the context of everyday practice. Second, there is a lack of feedback in

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In three of the studies described above (in the order they appear: Anderson & Bird, 1995; Joram & Gabriele, 1998; Gill, et al, 2004) researchers planned the courses in order to challenge and influence preservice teachers' beliefs. Wideen et al. (1998) suggest that if teacher education programs are designed considering teacher candidates' beliefs, they will be more productive in promoting learning to teach. Wideen et al. address the first step in this process by making preservice teachers reconsider their own beliefs. Although both the Anderson and Bird (1995) and Gill et al (1998) studies were based on this idea, the impact was limited, especially in the Anderson and Bird study. This might suggest the need for more careful planning including feedback or counter-arguments for preservice teachers' beliefs, similar to what was done in the Gill et al. study.

In summary, preservice teachers' beliefs are considered as very important factors in designing and providing conditions and opportunities in teacher education programs that allow for the transfer of knowledge and skills from preservice experiences to the inservice experiences (Cooney, 1985). However, preservice teachers' existing images of teaching and learning at schools decrease the impact of teacher education programs and make it difficult for the teacher educators to estimate the impact of their programs. Although reflection is a key in inducing change in beliefs during preservice education, it is also known that it is very difficult to convince preservice teachers to examine and change their own beliefs and there is always a tendency to filter the new experience based on the existing

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Beginning Teachers' Beliefs: The Impact of Real School Contexts

Beginning teachers start to teach in schools with their preservice trainings and beliefs as reference points. Even though they have some teaching experience as a student teacher, beginning teachers have full responsibility for teaching one or more courses for the first time. They have to deal with two main assignments as a teacher: to teach, which they have been hired for, and to learn to teach. However, the latter in particular requires time, effort, and resources which beginning teachers mostly lack (Wildman, Niles, Magliaro, & McLaughlin, 1989). As studies showed that teacher education has limited impact on preservice teachers' beliefs, what beginning teacher can draw upon is mostly reduced to their student teaching experiences and beliefs from pre-college years. These preexisting beliefs are more central and more influential on their practice compared to some beliefs gained during the teacher education. Moreover, beginning teachers do not realize the difficulty of simultaneously dealing with various factors and actors such as students, curriculum, parents, and administrators, until entering the school contexts (Flores & Day, 2006). The nature and causes of these difficulties are described here because of their relation to beginning teachers' beliefs carried to the initial years.

Veenman (1984) gives a comprehensive review and analysis of studies about beginning teachers' perceived problems. He defines beginning teachers to be teachers in their first three years and investigates the nature of and reasons for the "reality shock" and changes in attitudes and behaviors of beginning teachers. In reviewing the studies from different

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from different countries, he identifies difficulties that appear while beginning teachers try to carry out the tasks. These difficulties are likely to cause delays in the goals of beginning teachers.

"Reality shock" is the term used to address the "collapse of the missionary ideals formed during teacher training by the harsh and rude reality of everyday classroom life" (Veenman, p.143, 1984). Although the term suggests a short time period, beginning teachers' reality shock is continuous and takes longer time. Similarly, Wideen et al. (1998) reviewed empirical studies about learning to teach and documented that beginning teachers experience reality shock in their first-year of teaching, especially when they are not sufficiently prepared to teach. Reality shock reveals itself through change of behavior and change of attitudes. Beginning teachers are likely to change their teaching even when it contradicts their beliefs, due to external pressures. When beginning teachers' practices change from progressive teaching to traditional teaching, their attitudes and beliefs change in the same direction as well (Müller-Fohrbrodt, Cloetta, and Dann, 1978, as cited in Veenman, 1984).

In summarizing several studies, Veenman (1984) claims that the process of becoming a begining teacher starts with a rather traditional period of instruction as pre-college students, continues with a relatively progressive period in a teacher education program, and is followed by a powerful reformulation of beliefs and attitudes towards the traditional ones. He cautions that the progressive period may be the general impact of the university rather than the teacher education program. Moreover, the impact of the progressive period is likely to differ by personality, nature of the subject matter, teacher education period, and the conditions in the schools. When beginning teachers have more contradictions

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contradictions between their ideals developed through teacher education programs and the reality of the schools, they tend to develop authoritarian attitudes and beliefs.

The impact of the teacher education courses on beginning teachers decreases as they have more experience at school, where structure of schools, administrators, and students are more likely to exert an impact on beliefs, as Veenman (1984) reports. He addresses several problem areas of beginning teachers' that are most seriously perceived. The most mentioned ones, classroom discipline, motivating students, and dealing with students' individual differences, are related to the interaction between the teacher and the students. Similarly, Wildman et al. (1989) point to students, colleagues, school context, and parents as major sources of influence on the socialization of beginning teachers, where their existing beliefs about these populations often contradict with their experiences, especially in the case of beliefs about and experiences with students. Examples of studies documenting the impact of contextual factors on beginning teachers' beliefs and experiences are reported here.

In a study conducted by Wilcox et al. (1992), the impact of a series of three mathematics courses on number theory, geometry, and probability and statistics, a methods course, and a curriculum seminar on preservice teachers' knowledge and beliefs was investigated in the last two years of teacher education program and the first year in teaching. The courses were developed to give more conceptual knowledge to the preservice teachers about mathematics and teaching and learning mathematics. Data included field notes and videos of mathematics courses and audio recordings of small group work in the mathematics content courses and questionnaires, and samples of preservice teachers' works. Among the 23 preservice teachers, three were selected for more intens

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more intensive study and were interviewed and observed during their first year of teaching.

The three beginning teachers in the Wilcox et al. (1992) study had several beliefs about the nature, teaching, and learning mathematics as a result of their previous experiences as a student and their preservice education. Although participants had similar responsibilities such as providing learning activities, creating mathematical tasks, and use of instructional time, they responded to these responsibilities in different ways due to their beliefs. These beliefs were about mathematical knowledge, effective ways of mathematics teaching, and the extent that they viewed the context as limiting their teaching. Moreover, there were contextual factors such as time, curriculum guides in their district, and expectations of other teachers and supervisors. These factors had less influence when the participants had a well-established set of beliefs. In one case, a teacher did not have a definite set of beliefs, which made her accept other teachers' ideas and not evaluate their appropriateness for her goals. These other teachers' practice differed along several dimensions, including the extent to which teachers engaged students in problem solving, provided more exercises, or made mathematics classroom more interesting through different tasks without considering their connectedness. The researchers concluded that even providing preservice teachers with non-traditional models of mathematics teaching and learning integrated with their content knowledge courses might not be sufficient to develop knowledge and beliefs about teaching other than knowledge transmission. They suggested that the contextual factors existing in schools where they teach as beginning teachers and how these factors challenge newly formed orienta

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The limiting impact of contextual factors on beginning teachers' beliefs and practices is reported in several studies. Raymond (1997) conducted a study in which she investigated beginning elementary teachers' mathematics related beliefs, major factors impacting their beliefs and mathematics teaching practices, and the degree of consistency between the beginning teachers' beliefs and practices. She worked with six beginning teachers who were graduates of the same teacher education program by conducting interviews, classroom observations, analysis of written samples, and questionnaires.

Among these beginning teachers, Raymond (1997) focused on one with traditional mathematics beliefs and non-traditional learning and teaching beliefs about mathematics. Her traditional beliefs about mathematics characterized mathematics as a collection of numbers, facts, and rules that should be memorized. She had non-traditional beliefs about teaching and learning. For her, teachers should provide students with activities, manipulatives, and different views. Students could learn through discovery, reasoning, and working in groups. Although her beliefs about teaching and learning mathematics were mainly non-traditional and student-centered, her teaching practice was teacher-centered. She depended on questioning rather than discovery where students were quietly following her teaching. She did not use manipulatives during her teaching and she evaluated students' learning through their correct answers on tests and homework. This participant taught in traditional ways inconsistent with her non-traditional beliefs about teaching mathematics.

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In explaining these inconsistencies between her beliefs and practices, the participant addressed time concerns, lack of resources, the pressure of standardized testing, and students' behaviors as possible reasons. Among them, she ranked time concern and classroom management as the major causes of inconsistency. Raymond (1997) claimed that since contextual factors put pressure on the participant, she had inconsistencies between her non-traditional beliefs and traditional practices. More generally, beginning teachers in this study claimed that the impact of preservice experiences on their teaching practice was negligible and the relationship between their beliefs and preservice training was moderate. Moreover, they indicated that pre-college experiences were the major factor influencing their beliefs about the nature of mathematics, while their teacher education and student teaching experiences were the major factors impacting their beliefs about teaching and learning. The results of this study showed that even when beginning teachers have non-traditional beliefs about teaching and learning, they inclined towards traditional practices due to the contextual factors, which was mentioned by Veenman (1984). Raymond concluded that teacher education programs would have more indirect impact on teaching practice of beginning teachers if they were designed to influence preservice teachers' beliefs.

The factors beginning teachers face when they start teaching seem almost universal. Recently, similar results were found in Portugal with 14 beginning teachers in a study by Flores and Day (2006). The researchers investigated the ways beginning teachers' identities were shaped and reshaped during the first 2 years of teaching. Most of the participating teachers were in rural contexts, teaching middle school and high school courses in areas such as physics, chemistry, biology, mathematics, music, and language,

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with additional school duties. Through semi-structured interviews, questionnaires implemented to all staff and students in the school contexts participants taught, students' essays about the change in their (participant) teachers, beginning teachers' annual formal report, and their reflections about own practice, three main factors were found influencing beginning teachers' identities. They are (i) prior experiences as pre-college students; (ii) preservice training and student teaching practices; and (iii) teaching contexts.

The participants considered their former teachers as role models when they viewed themselves as teachers. They expressed the influence of their teachers and how their observations of these teachers helped them in responding to several practical situations. Teacher education programs had a relatively weak impact on the way participants viewed themselves as teachers because teaching was not the first profession choice of most of the participants. Beginning teachers believed that the teacher education programs did not prepare them sufficiently for the complexity of school teaching and they experienced a disparity between their ideals as a preservice teacher and the classroom reality. When they considered their teaching contexts, they addressed a mismatch between their initial beliefs about teaching and the roles they were expected to assume as beginning teachers. Initially, classroom management was a problem for the beginning teachers. Classroom management concerns made them incline towards teacher-centered practices even though their initial beliefs were not teacher-centered, a finding which Raymond (1997) also addressed. Some of the participants revisited their beliefs about teaching and teacher identity as a result of the contradiction between what they experienced and what they actually wanted to experience in the classroom. Although they

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initially mentioned responding to students' learning and using various teaching methods (e.g. discovery, manipulatives, group work) as characteristics of good teachers, their actual teaching did not model these beliefs. Despite the impact of previous experiences on beginning teachers' beliefs about their teacher identity, the impact of teaching contexts was the key in reshaping these identities. Flores and Day (2006) study showed that previous experiences, teacher education programs, and teaching contexts were the factors in construction, deconstruction, and reconstruction of beginning teachers' professional identities.

The studies about beginning teachers summarized above showed that beginning teachers have to deal with contradictions between their prior beliefs and the constraints of the real teaching contexts. They have several survival concerns such as classroom management, students' learning, building relationship with the students, limitations of teaching contexts, availability of resources, and effective use of time (Fuller & Brown, 1975, as cited in Veenman, 1984), that they have to deal simultaneously. Among them, classroom management seems to be the most important problem. Even when beginning teachers have non-traditional or mostly student-centered beliefs about teaching and learning, they tend to perform teacher-centered practices in order to maintain classroom order. Drawing from his study on inservice development programs Guskey (1986, as cited in Pajares, 1992) indicates that change in behavior is not a *result* of change in beliefs, but is a *cause* for belief change. Hence, it is likely that beginning teachers' teacher-centered practices may result in teacher-centered beliefs as they become more experienced in the field.

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Personal history seems to play an important role in the way beginning teachers make sense of real teaching contexts. They start teaching with generally well-established beliefs about their roles, students' roles, and the way content should be considered. However, personal history often contradicts the cultural contexts of schools. Preservice and beginning teacher research has concluded that there is a need for an approach in teacher education programs by which preservice teachers with different beliefs will realize the complicated nature of classroom and school contexts and understand that these contexts will vary even in the same school (Holt-Reynolds, 1992). Opportunities to experience and reflect on personal biography and the contexts of schools may help beginning teachers deal with possible contradictions better (Flores & Day, 2006).

Studies focusing only on teachers' initial years, such as Flores and Day (2006) and Raymond (1997) provide valuable information for teacher induction and teacher education. In the case of the Flores and Day study, participants' students, peers and school administrators were considered as a source of information for investigating beginning teachers' difficulties in the field. However, the preservice experiences of participants in these two studies remain unexplored. Hence, inferences made for participants' beliefs gained during preservice education and for the interaction of these beliefs with contextual factors in teaching lack information about the nature of experiences underlying these beliefs. Research that comprises *both* preservice and initial years of teaching and investigates changes in preservice teachers' beliefs through the experiences in both preservice and inservice contexts, such as Wilcox et al. (1992) study, would inform research and practice in both teacher education and teacher induction, processes that should be a continuum (Feiman-Nemser, 2001).

Summary and Conclusions

Research on beliefs shows that preservice teachers' beliefs about teaching, learning, and content are generally resilient to change. Research on the impact of teacher education documents that even when the interventions were carefully designed to change preservice teachers' beliefs, several factors reduced the impact of these interventions. Among these factors, the most important ones were preservice teachers' pre-college beliefs and their overall perception that teacher education programs are not effective in learning how to teach. Moreover, any changes that might have occurred in preservice teachers' beliefs during time in teacher education programs did not persist beyond the beginning years. Contextual factors such as classroom management and students' differences generally did not provide opportunities for beginning teachers who had non-traditional beliefs to maintain those beliefs and conduct practice reflecting them.

As this review suggests, the research literature on teachers' beliefs still has missing pieces or uninvestigated areas. First, beliefs of teachers in the Turkish educational context, which has several features that are different from the educational context of the U.S., has not been extensively explored yet. Among the contextual differences, the first one is the informal teaching (which will be explained in the Methods chapter) that preservice teachers in Turkey are generally involved before they graduate from teacher education programs. Unlike in the U.S., preservice teachers in Turkey often have considerable teaching experiences when they start to teach full-time. Second, teacher education programs in Turkey do not involve an internship year. The internship period is the first year of teaching in Turkey and it is independent of the teacher education programs at universities. Although there are mentor teachers ostensibly responsible fo

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esponsible for monitoring beginning teachers, most beginning teachers do not even meet ieir mentors. Elementary school teachers (including content area teachers for grades 6-8) re inspected every year by the Ministry of National Education. Beginning teachers' esson plans and practice are generally evaluated only by the inspector, without any revious monitoring or reflection that a mentor could have provided. Finally, there is a ational curriculum to follow strictly which does not always address the students' needs nd presents teachers with the dilemma of responding to students' needs or keeping the urriculum pace (Yildirim, 2001). Thus, the national curriculum and related informal ducational contexts frame preservice and beginning teachers' experiences in pre-college ears, teacher education programs, and initial years in teaching in Turkey.

Most of the studies described here were conducted in the U.S., which is extremely ifferent from Turkish context in terms of the structure of teacher education programs nd schooling. Hence, the findings of previous research about preservice and beginning achers' mathematics related beliefs cannot be considered to have strong implications or Turkey. Therefore, there is a need for Turkish studies in order to investigate reservice and beginning teachers' mathematics related beliefs in preservice training and ational curriculum context. Such studies will address both universal themes in and ontextual factors for belief research.

A second unexplored area in the research literature on beliefs concerns the effect f the national curriculum on teachers' beliefs. Teachers' beliefs are not generally ddressed in studies conducted in national curriculum contexts. National curriculum ontexts are mostly studied in terms of student learning (e.g., Strand, 1997), teachers' ractice (e.g., Silcock, 1992), and issues appearing as a result of policy change such as assessment (e

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assessment (e.g., Gipps, 1992). Moreover, a national curriculum is perceived as helpful for the beginning teachers in dealing with difficulties such as effective lesson planning, classroom management, and employing suitable pedagogical approaches (Kauffman, Johnson, Kardos, Liu, and Peske, 2002). However, to what extent this help is present in the national curriculum context and how the context impacts and interacts beginning teachers' beliefs have not been addressed yet.

As third area that is not represented in the literature, existing research also indicates a need for extended scope in investigating the change or development of teachers' beliefs. Belief studies generally focus on relatively short periods of teacher education process or initial years while describing preservice and beginning teachers' beliefs and investigating factors impacting them. However, these snapshots of beliefs do not explore their developmental process, how they were shaped, and what impacted the process. Longitudinal studies investigating beliefs of preservice and beginning teachers are rare in the field of education, leaving the impact of different experiences gained at different periods unexplored. Thus, there is a need for investigating the development of teachers' beliefs beginning from early years in the teacher education programs through their initial years as a teacher. Such research will address critical issues for teacher educators in designing interventions that start from preservice years and continues through the initial years.

The inconsistencies among the data analysis procedures in belief research present a fourth missing piece in the belief literature. Belief research presents a problem of subjectivity due to the nature of beliefs. Many belief studies investigate teachers' beliefs through interviews which are analyzed without any definite framework. Moreover, researchers ge

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researchers generally do not present the degree of consistency of basic assumptions, such as definition of beliefs and modes of inquiry, across the studies from which they derive beliefs for their own studies. Thus, data analysis is based on the beliefs researchers derive from the literature, depending on what they *believe* to be important and the degree they consider consistency. A similar risk of poor data analysis exists in studies where researchers derive codes from their data where data is influenced by data collection methods and derived beliefs are influenced by researchers' decisions. This shows that researchers generally use subjective data analysis tools to infer teachers' beliefs from verbal data, which is likely to produce inconsistent results when used by other researchers. Thus, there seems to be a lack of a common framework in belief research that would provide more consistent and less idiosyncratic analyses of teachers' beliefs. The lack of framework also limits the results of belief research across different educational contexts or different groups of teachers.

Considering previous studies' findings and missing pieces of this literature, preservice and first-year teachers' mathematics related beliefs were investigated through a cross-sectional analysis of the impact of a teacher education program in Turkey and a longitudinal analysis of the impact of first-year teaching. The present study addresses and contributes to studies about inservice and preservice teachers' beliefs in several ways. First, it investigates year level differences in preservice teachers' mathematics related beliefs through the teacher education program. As documented previously, the existing literature investigated the influence of short interventions, but did not investigate the overall impact of teacher education programs through the years. The present study addresses a more comprehensive investigation of the teacher education program through the year l

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CHAPTER 3

A COMBINED FRAMEWORK OF MATHEMATICS RELATED BELIEFS

In this chapter, the framework that was used to analyze the data (interview transcripts of preservice and inservice teachers) in this study is described in detail. This framework integrates three similar models of teachers' mathematics related beliefs proposed by Thompson (1991), Lindgren (1996), and Ernest (1989).

As mentioned previously, prior research has problems with inconsistent data analysis frameworks where the assumptions underlying these frameworks are often ignored and data analysis tools are highly subjective in nature. Moreover, belief studies do not tend to use existing data analysis frameworks, but provide more to the high number of existing frameworks. A contribution of this study is a combination of three of frameworks derived from the literature considering the consistency across their assumptions. In other words, a major problem in belief research is eliminated in this study by *recycling* existing consistent frameworks.

Thompson's Framework

Thompson (1991) claims that teachers' conceptions of mathematics are affected by personal previous educational and instructional experiences and the way these experiences were interpreted and internalized by the teachers. She uses "conceptions" instead of "beliefs" but she also claims elsewhere that the difference between these two concepts might not be drastic (Thompson, 1992). She formulizes conceptions as bi-products of experiences (Thompson, 1991), which is the way beliefs are considered in this study. Thus, the conceptions she addressed will be considered as beliefs as well.

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She proposes a framework for investigating and analyzing the development of teachers' conceptions of mathematics teaching. This framework is developed using the results of her five-year work with seven preservice and five inservice teachers. Thompson (1991) claims that the framework documents what she has observed as a "fairly consistent pattern of development of teachers' conceptions of mathematics teaching" (p.8). Since her framework is limited to the experiences and the existing conceptual schemes of the teachers she worked with, she asks other researchers to examine the viability of her framework.

In this framework, she categorizes development of teachers' mathematics related conceptions in three developmental levels: *Level 0*, *Level 1*, and *Level 2*. She characterizes the levels depending on the conceptions of: (a) mathematics; (b) learning mathematics; (c) teaching mathematics; (d) roles of teachers and students; and (e) evidences of student knowledge and criteria for judging correctness, accuracy, or acceptability of mathematical results and conclusions. The characterizations of the levels are given below (the complete list of Thompson's (1991) characterizations is given in Appendix A).

Level 0. Mathematics is conceptualized as using arithmetic skills in daily life. Hence teaching mathematics is focusing on the development of students' skills in arithmetic. This is performed through memorization of the mathematical knowledge which is composed of facts, rules, formulas, and procedures.

The teacher's role is limited to demonstrating the facts and procedures in the classroom and the student's role is to imitate and practice those procedures until they become a habit. The goal of mathematics teaching and problem solving at this level is to implement th

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implement the correct procedure or obtain the correct answer, usually in the ways demonstrated in the class. Mental processes are not considered during problem solving. The teacher or the book is generally considered as the authority for mathematical knowledge.

Level 1. At this level, mathematics is still considered as a collection of facts and rules, but the principles behind the rules are realized. This slight shift is considered to be a result of the use of instructional representations and manipulatives in teaching. However, this new pedagogical approach to teaching mathematics (such as use of manipulatives) is not considered as a way of improving conceptual understanding, but rather increasing the enjoyment of students in the mathematics classroom. Problem solving is seen as isolated from the mathematical concepts and problems are taught separately with almost no relation to the concepts. It is not seen as a way to teach mathematics.

The teacher has similar roles described in *Level 0.* Student's role is extended and it includes some understanding of the principles behind the procedures. Although there is a change in the way mathematics and mathematics teaching is considered, there is still an authority who decides on the correctness of mathematical ideas.

Level 2. Thompson does not specifically claim much about Level 2 conceptions of the nature of mathematics. She only claims that centrality of the mathematical ideas are realized at this level. Unlike the Level 1 teaching beliefs, using materials and different methods in mathematics teaching targets conceptual understanding. Mathematics teaching for understanding includes students' engagement. Thus, teacher is considered as a guide in catalyzing students' thinking. The teacher allows students to express their ideas in order to have a better understanding of their learning process. The student's role is increased to understanding the logical connection between the mathematical concepts and ideas. Students are expected to participate in the mathematics classroom by expressing their ideas and reasoning. Hence, proving and generalization are seen as a way of learning mathematics.

Critical Arguments and Points in Thompson's Framework

Thompson (1991) claims that the development of mathematics related conceptions is not a discrete process. The participating teachers in her study continued to have higher or lower level conceptions about mathematics simultaneously even if they were considered to fit a particular level. The teachers who initially had Level 0 conceptions eventually moved to Level 1 conceptions during her studies with them. However, none of the teachers were able to have fully developed Level 2 beliefs. Thompson claims that the patterns of movement from one level to the other suggests a relatively easy move from Level 0 to Level 1 compared to that of from Level 1 to Level 2. She explains this difference by the nature of restructuring needed in order to achieve the level change. Moving from Level 0 conceptions to Level 1 conceptions requires no major structuring of conceptual schemes, but an expansion of or broadening in Level 0 conceptions. However, moving from Level 1 to Level 2 requires "that a teacher experience numerous occasions to become aware of and question his deeply rooted ideas and unexamined assumptions of what it means to know, learn, and teach mathematics" (p.14). Within this complicated process of restructuring, Thompson cautions that teachers' resistance to change their conceptions should not be underestimated.

Thompson's (1991) framework appears as a result of a qualitative study with few participants. In order to have a more accurate and stronger analysis tool, Lindgren's (1996) framework, which is a modification of Thompson's framework in Finnish context through both qualitative and quantitative methods, is additionally considered here.

Lindgren's Framework

Lindgren (1996) emphasizes the role of previous experiences on the mathematics related beliefs of preservice teachers. She characterizes mathematical beliefs as implicit personal mathematical knowledge. For Lindgren, conscious beliefs form conceptions. All conscious and unconscious beliefs constitute a belief system. She names the conscious or unconscious beliefs as "views" when the object of the belief system is mathematics or mathematics teaching and learning.

Lindgren's (1996) study with preservice teachers in Finland seems to validate Thompson's (1991) framework. Her study includes the use of both quantitative ($N = 163$) and qualitative ($N = 12$) methods. She initially uses a Likert-type belief inventory and then conducts interviews with a selected group of participants. Her study results in a framework with three partly overlapping categories named Rules and Routines, Discussion and Games, and Open-Approach, which she claimed corresponded to Thompson's Level 0, Level 1, and Level 2, respectively. The model that Lindgren proposed emphasized the teaching and learning of mathematics, and roles of teachers and students. The categories and their characterizations are given below (the complete list of Lindgren's characterizations is given in Appendix A).

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Rules and Routines - RR (Level 0). This category refers to an understanding of teaching mathematics based on routine procedures that should be demonstrated by the teacher and be memorized by the students.

Discussion and Games - DG (Level 1). This category characterizes teachers as having different approaches in teaching such as using games and promoting classroom discussions.

Open-Approach - OA (Level 3). This is the category when students have responsibility for their own learning and where teachers encourage and guide students. Mathematics is a way of thinking operationalized by problem solving.

Critical Arguments and Points in Lindgren's Framework

Lindgren (1996) claims that there are sublevels in the Discussion and Games (Level 1) area where common sub-areas with the other two levels appear. Figure 1 in Lindgren's study (1996, p.114) illustrates this structure.

In Lindgren's (1996) illustration, GR (Games and Rules), GRO (Games, Rules, and Openness), and GO (Games and Openness) are the intersection areas where teachers have beliefs from at least two different belief levels. For example, GR (Games and Rules) is the intersection of Rules and Routines (Level 0) and Discussion and Games (Level 1), where teachers might believe that facts and rules are the focus of mathematics but they might also promote class discussion. Lindgren's (1996) analysis yields a conjoint area of all three levels (GRO – Games, Rules, and Openness within Level 1) where teachers simultaneously believe in issues from all three levels. The existence of conjoint areas in Lindgren's study suggests that Discussion and Games level (Level 1) is the area of development of preservice teachers' beliefs about teaching mathematics.

The existence of conjoint areas shows that Lindgren's (1996) levels are similar to Thompson's (1991) levels in terms of continuous structure. As can be seen from the characterization of categories, Lindgren's framework is more of a teaching and learning framework for mathematics related beliefs, as most belief statements directly address teachers' or students' roles but not the nature of mathematical knowledge. When combined with the Thompson's framework, Lindgren's framework brings additional descriptions for beliefs about teaching and learning, and make Thompson's framework stronger in these areas. However, beliefs related to the nature of mathematics are not mentioned explicitly in Lindgren's framework. Hence, in order to supplement these two frameworks with a better description of beliefs about the nature of mathematics, Ernest's (1989) model of mathematics related beliefs is considered as a part of the final framework used here.

Ernest's Model

Ernest (1989) proposes a model of mathematics teachers' knowledge, beliefs, and attitudes; however, he does not give a definition of beliefs. Rather, he uses "beliefs" and "conceptions" interchangeably and mentions that teachers' beliefs about the subject area, teaching, and learning have a considerable impact on their teaching. He introduces three views of the nature of mathematics where he claims that teachers may combine different elements from different views during their practices just as Lindgren (1996) claims. He does not mention a developmental nature in these views, but they represent a range from static views to dynamic views. Ernest also links these views to beliefs about the teaching and learning of mathematics. The description of views of mathematics and their links to teaching a

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teaching and learning are given below (the complete list of Ernest's characterizations are given in Appendix A).

Instrumentalist view. Mathematics is a set of tools which include unrelated facts, rules and skills used in order to reach an external end product. A teacher with instrumentalist view of mathematics may insist on single correct ways of solving problems where the mathematics curriculum is about mastery of rules and skills without mentioning meaningful relationships between these.

Platonist view. Mathematics is a static but combined body of knowledge in which there are structures and truths connected to each other by logic and meaning. Mathematics is not created but discovered. A platonist teacher may also insist on single correct answer while implementing a curriculum that focused on the main and unifying concepts of mathematics.

Problem-solving view. Mathematics is a dynamic, problem-driven, continually expanding field which includes a process of knowledge generation. Mathematics is not seen as a finished product. A teacher with problem-solving view may accept children's methods and ways of dealing with mathematical tasks. Mathematics curriculum emphasizes the procedure that mathematical knowledge is produced.

Critical Arguments and Points in Ernest's Framework

Although not developmental in nature, Ernest's (1989) framework for the beliefs about the nature of mathematics and their links to teaching and learning seems parallel to Thompson's (1991) characterization of levels. Thompson's Level 0, Level 1, and Level 2 can be associated with Ernest's instrumentalist, Platonist, and problem-solving views respectively. His framework completes the lack of characterization of beliefs about nature of mathematics for especially Level 2 beliefs in Thompson's framework.

Combined Framework

Thompson's (1991) framework is an overall framework that draws a general developmental picture of mathematics related beliefs. It is used as the main analysis framework of the present study. The terminology (Level 0, Level 1, and Level 2) and the characterization of the levels are used as a starting point. In order to make the characterizations of the levels richer, Lindgren's (1996) characterizations are also inserted into the main framework. These two studies used different methods in order to frame preservice and inservice teachers' beliefs: Thompson worked with 12 teachers for over 5 years, where Lindgren worked with a total of 163 preservice teachers using a quantitative approach and with 12 of them using a qualitative approach in order to improve Thompson's model in the Finnish context. Hence, the combination of these frameworks provides a richer model especially in terms of teaching and learning beliefs covering various contexts.

The combination of Thompson's (1991) and Lindgren's (1996) frameworks are supplemented by Ernest's (1989) model of conceptions of the nature of mathematics. Table 3.1, below, provides the main points of the "Combined Framework" that will be used as the analytic framework in the proposed study, arranged in Thompson's levels. The complete framework is given in Appendix A.

Table 3.1

A Summary of the Combined Framework for Analyzing Teachers' Beliefs.

Levels	Main Characteristics
Level 0	*Nature* • Mathematics is composed of unchanged facts, rules, and basic arithmetic, and usage of them in daily life. • The goal of mathematics instruction is to obtain single correct/accurate answer. • Problem solving is getting answers to story problems by implementing "rules of thumbs." *Teaching* • Teachers transfer the mathematical knowledge in the form of discrete rules and procedures without consideration of conceptual understanding. *Learning* • Students can learn only by listening to the teacher, memorizing and imitating teachers' procedures.
Level 1	*Nature* • Mathematical knowledge is composed of facts and rules, but there are connections between these. • Problem solving is finding strategies to problems unrelated to the content. *Teaching* • Teachers use pedagogical approaches but do not consider cognitive outcomes. • Mathematics instruction is using concrete representations as a justification of procedures and making students enjoy. *Learning* • Students put some effort to understand concepts in mathematics demonstrated by the teacher.
Level 2	*Nature* • Mathematical knowledge has a dynamic structure and it is continuously produced. • Problem solving is the way of knowledge construction. *Teaching* • Teachers guide and provide opportunities for students' understanding through appropriate pedagogical approaches. • Mathematics instruction is an ongoing teacher guided process of student-driven knowledge construction. *Learning* • Students actively engage in mathematical inquiry.

The development of mathematics related beliefs is not a discrete process where one is placed in one of the levels instantly. Rather, it is a continuous process as explained in Thompson's (1991) and Lindgren's (1996) frameworks. Table 3.1 shows that Lindgren's and Ernest's (1989) model supports Thompson's claim about the differences among nature of moving from one level to the other. The differences between the characterizations of Level 0 and Level 1 are not dramatic in the combined framework, but still distinguishable compared to the differences between Level 1 and Level 2 characterizations, which are quite definite.

Any collection of mathematics related beliefs in the combined framework can be considered as an individual belief system as defined in the previous chapter. Since belief systems are cognitive structures open to reorganization due to the nature of existing and new experiences (Thompson, 1992), the development of teachers' mathematics related beliefs, which corresponds to a change in level in the case of the combined framework, is a dynamic process. Moreover, the cluster nature of belief systems provides a justification of holding beliefs from different levels of the combined framework.

The belief levels in the framework exemplify belief clusters that Green (1971) mentioned. The belief clusters can be considered as containers or sets of beliefs within a belief system and they exist mostly in isolation. Belief clusters allow one to hold several conflicting beliefs together. They also explain Thompson's (1991) and Lindgren's (1996) findings in which teachers had beliefs from different belief levels at a time. Therefore, the framework also exemplifies and defines three clusters of mathematics related beliefs for preservice and inservice teachers.

In order to make the data analysis more systematic, the framework is organized under three belief areas depending on how previous studies categorized preservice and inservice teachers' mathematics related beliefs: the nature of mathematics, teaching mathematics, and learning mathematics. *Beliefs about the nature of mathematics* consist of beliefs about nature of the mathematical knowledge and what it means to know, understand and perform in the subject area. *Beliefs about mathematics teaching* include beliefs about teachers' responsibilities, pedagogical content knowledge of mathematics, and who should control students' mathematical activity. Finally, b*eliefs about learning mathematics* consider beliefs about learners, learning and nature of mathematical ability.

The combined framework provides a detailed characterization of mathematics related beliefs and better analysis of the interview transcripts in this study. In the present study it is used in the Turkish context, which is different than the U.S. and Finnish contexts where Thompson (1991) and Lindgren (1996) frameworks were emerged and tested. Although the combined framework is the main tool to analyze preservice and inservice teachers' mathematics related beliefs, this study is also an examination of the viability of the framework.

CHAPTER 4

METHODS

This study explores, identifies, and interprets the mathematics-related beliefs of 12 first-year (inservice) and 20 preservice Turkish middle school mathematics teachers who had graduated or had been studying at the same teacher education program (Elementary Mathematics Education – EME) in 2003 and 2004.

The major data source of investigation was one-on-one interviews with the first-year (inservice) and preservice teachers. Each participant's mathematics-related beliefs were identified from their interview data using the framework of mathematics-related beliefs described in the previous chapter. Inservice and preservice participants' beliefs were particularly investigated in relation to their experiences during the specific teacher education program and in their teaching contexts (for inservice participants) to understand if these experiences had an impact on their beliefs.

The method of inquiry will be explained in detail in this section. After primary and secondary research questions are introduced, the contexts of the study will be described. Next, the participants of the study and the instruments will be explained in detail followed by the procedures of data collection and data analysis. Since the study is conducted through qualitative methods, the issues related to the quality of the research will be addressed in this section as well.

The data for this study was collected in 2003 and 2004 and some of the participants were involved in both 2003 and 2004 data collections. The data collection procedures in these two years will be referred to as "2003 study" and "2004 study."

Research Questions

Inservice and preservice middle school mathematics teachers' mathematics-related beliefs were investigated through the following primary and secondary research questions:

1. How does the Elementary Mathematics Education (EME) program affect the preservice middle school mathematics teachers' (2^{nd}-, 3^{rd}-, and 4^{th}-year students) beliefs about the nature, teaching, and learning of mathematics?
    a. What are the beliefs of preservice teachers about the nature, teaching, and learning of mathematics?
    b. What might be the crucial year/course(s)/practice(s) in the EME program that affects those beliefs? How? Why?
2. How does the Elementary Mathematics Education (EME) program affect the first-year (inservice) middle school mathematics teachers' beliefs about the nature, teaching, and learning of mathematics?
    a. What are the beliefs of first-year teachers about the nature, teaching, and learning of mathematics?
    b. What might be the crucial year/course(s)/practice(s) in the EME program that affected those beliefs? How? Why?
    c. How does the first-year of teaching affect the first-year teachers' beliefs about the nature, teaching, and learning mathematics? Why?

The participants, data collection, and the data analysis will be described in relation to the primary research questions after the contexts of the EME program and the Turkish educational system are be described.

Contexts

Although the study is related to the Elementary Mathematics Education (EME) program, it is crucial that the general structure of Turkish Educational System is introduced. This section will give a picture of the general teaching context of the first-year teachers as well as the participants' pre-college education context.

The Elementary Mathematics Education (EME) Program

The study was conducted in the Department of Elementary Education[1] in the College of Education in Middle East Technical University (METU) in Ankara, Turkey. METU is a technology-oriented university, and the language of instruction is English. New students are administered METU's own English proficiency examination at the beginning of the fall semester every year in order to determine their skills in English language. The students who cannot pass the examination are required to study in the School of Basic English for one year. Those who pass the examination are considered freshman and start taking departmental courses. The students in the School of Basic English take the English proficiency examination again at the end of the spring semester and are required to pass this examination in order to qualify as freshman.

The Department of Elementary Education offers B.S. degrees in three undergraduate programs: Elementary Mathematics Education with a minor in Elementary Science Education, Elementary Science Education with a minor in Elementary

[1] Note that the program name uses the term 'Elementary' in that it trains teachers of grades 1 to 8, which are collectively referred to in Turkey as the elementary grades. The present study targets what US educators would refer to as middle school teachers, however.

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Mathematics Education and Early Childhood Education. All three programs are four-year programs that aim "to develop teachers with a sound understanding of how children learn" who are "confident in using technology; capable in problem-solving; attentive to human rights, democracy, and ethics" (Middle East Technical University, 2005). The programs in the department emphasize critical thinking, personal reflection, and professional development of preservice teachers. The graduates of the program are qualified as teachers who can teach in elementary schools (grades 1 to 8) as mathematics and science teachers and early childhood centers as early childhood educator (Middle East Technical University, 2005). The programs in the Department of Elementary Education started to accept its first students in 1998. These students studied one year of English preparation classes and started their freshman year in the 1999 fall semester. The first students of the EME program graduated with B.S. degrees in June 2003. The department faculty had only one assistant professor with a mathematics education focus at the time of both the 2003 and the 2004 studies. The EME program was supported by the faculty in the Department of Secondary Science and Mathematics Education in the College of Education at METU at that time.

The EME program focuses on mathematics, science, and introductory courses to teaching and education in the first two years, followed by mathematics teaching courses in the 3rd and 4th years (see Appendix B). The program includes nine courses from the Department of Mathematics, four courses from the Department of Educational Sciences and 11 courses from the Department of Elementary Education. There are a total of four courses in chemistry, biology and physics to support the minor degree in the Elementary Sci ence Education. Although there is no laboratory room for mathematics activities, the

EME program has mathematics laboratory equipment (such as geoboards) to be used in methods or other courses related to teaching mathematics.

The EME program requires three semesters of teaching practice courses at the second, seventh, and eighth semesters. Students are first assigned to collaborating schools and then to collaborating teachers in those schools. The first teaching practice course is based mostly on observation of the classroom and teaching context and the lives of teachers and students. The second and third teaching practice courses are generally based on both observation and practice. Besides the three semesters of teaching experience, most of the EME program students teach as private tutors or work at a Test Preparation Center (TPC)[2] during their studies in the program. Some of them work voluntarily at a student club project where lower socio-economic class students are brought to the METU campus during weekends and are taught in mathematics, science, and English in order to support their learning at school and to help them prepare for the national exams. Hence, students in the education programs at METU generally have some teaching experience (other than the required practice) either with individual students or in a classroom context.

The Educational System in Turkey and Teaching Institutions

The Ministry of National Education (MNE) is the institution of authority that decides on educational policies in Turkey. The MNE decides on the national curriculum and the examination procedures for all grades, all content areas, and all types of

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[2] Typically, university students in Turkey do not work at a job and study simultaneously. However, private tutoring is very common among all university students regardless of their major. University students generally tutor elementary or high school students either to support their learning or to prepare them for the national exams. The most popular content areas of private tutoring are mathematics, English, and physics. Some university students also work in Test Preparation Centers as tutors. More information about national exams and Test Preparation Centers are given in the following section.

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elementary and secondary schools. The teachers are placed in the public school system by the MNE. The process is from top to bottom and there are National Education Departments in every province that are responsible for implementing the policies at the province level. Organizationally, the MNE is under the control of the Prime Ministry.

Public and private schools in Turkey generally differ in the size of the classroom, the available resources (such as science laboratory, computer equipment, software, and books), improvement opportunities (such as research centers and course material development projects), and opportunities for extra-curricular activities for students (such as sports and arts). Note that the terms 'private' and 'public' mean the same thing in Turkey as in the US. Most Turkish students attend public (state-supported) schools, but a small percentage pay for private education.

Turkish elementary education aims to educate students as self-confident and environment-conscious individuals with the scientific thinking skills and the values of the Turkish culture. Mandatory continuous elementary education in Turkey comprises grades from one to eight. The first phase of elementary education consists of the grades from one to five where almost all content areas are taught by primary teachers. The second phase of elementary education includes the grades from 6 to 8, and content area teachers teach the courses. All public and private elementary schools implement the national curriculum in all content areas at the elementary education level, and they are inspected by the MNE officers each year for their curriculum pace and teaching and administrative-related issues. Instruction in elementary schools in Turkey can be characterized as text-book based and teacher-directed. Classroom population may vary from 20 to 70 depending on the population that the school serves.

Eighth grade students have to take a national examination (the Secondary Education Institutions Entrance Examination) which covers the concepts in the sixth, seventh, and eighth grade curriculum in order to attend better high schools. Secondary education aims to provide the students with the knowledge and skills to analyze various problems and to think about the solutions in order to participate as productive citizens of the country and to prepare students for higher education. Secondary education is considered to have two categories: General high schools (from grades nine to 12) [3] and vocational technical high schools. General high schools prepare students for the higher education and contain both examination-track and non-examination-track type high schools, while vocational technical high schools train students for jobs. Although general high schools in Turkey implement the national curriculum in all content areas at all grade levels, they differ in the quality of the education depending on the student population they serve. Since most of the general high schools take their students from the national examination administered to the eighth grade students at the end of the school year, examination-track general high schools are generally considered as superior due to their student population[4]. Moreover, the depth of the implemented curriculum differs in the different school types. For example, Science High Schools (an examination-track general high school type) implement the curriculum with more disciplinary approach and depth, whereas Regular High Schools (a non-examination-track general high school) lack this

[3] Secondary education in Turkey has increased from three years to four years beginning from the 2005-2006 school year. At the time of the study, the high school duration was still three years, comprising grades from 9 to 11. Hence, the high school context mentioned in this study will refer to three years duration.

[4] Only the 8^{th} grade elementary students who have a certain GPA of 7^{th} grade courses are allowed to take the national examination. Hence a population who is generally successful in school courses takes the examination.

approach and depth. General high schools are inspected by the MNE officers every five years.

Candidates who want to attend a university in Turkey are required to be a high school graduate (or be in the senior year) and take a central multiple-choice examination, the Student Selection Examination, which is held only once a year. The candidates are placed in the university programs depending on their scores and rankings. Most of the public universities and some private universities in Turkey have Colleges of Education that offer four-year or five-year teacher education programs.

Most of the teachers in Turkey are graduates of education colleges within universities. The rest are graduates of liberal arts colleges and they become teachers after completing a certification program provided by some of the universities in Turkey. Since 1999, public school teachers have been hired and placed by the MNE based on their scores in a central examination. Private schools, on the other hand, hire their own teachers. A high school or a middle school content area teacher generally teaches up to five different classes of students per week. Teachers generally do not have their own classrooms in Turkey, but the students in the same grade level are divided into sections and these sections have classrooms. In other words, students do not visit the teachers' classrooms but teachers visit the sections' classrooms. Although first-year teachers in public and private schools are considered interns, they are fully responsible for teaching the assigned classes and they have the same responsibilities that other teachers have. First-year teachers are considered interns and they have to attend several courses on the schooling system and teaching profession conducted by the MNE. To complete their internship, they have to pass an examination on the content of each of the MNE courses.

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Although each first-year public school teacher (an intern) is assigned a mentor who is an experienced teacher in intern's content area, continuous mentor-intern collaboration is not common in Turkey. Most first-year teachers do not even know or meet their collaborating mentors.

First-year teachers are generally assigned to the schools in rural areas. Rural area schools generally lack certain teaching materials and facilities in content areas such as computers for teachers or science laboratories. Another typical problem in rural area schools is the continuous teacher flow. Although many beginning teachers are assigned to rural area schools, they prefer to work in big cities. Thus, they ask for reassignment after they start teaching for several reasons such as attending a master's program or having a family. Many rural schools lack teachers who work in the same school for more at least one year. It is very common that rural area schools have five different teachers in a semester, one after another, who teach a certain content area. When the school does not have a certain content area teacher, the principals generally assign another teacher (who is not certified in that content) to teach. For example, if the school lacks mathematics teacher, the principal may assign science teacher or Turkish language teacher to teach mathematics.

Besides public and private schools, teachers also teach at Test Preparation Centers in Turkey. These centers prepare students for all sorts of national examinations such as the Secondary Education Institutions Entrance Examination (at the end of the eighth grade) and the Student Selection Examination (at the end of the high school or later). The focus of teaching in TPC is generally not on understanding the concepts but on the skills to solve multiple-choice questions in a limited time period. TPCs group students on their grade levels and generally provide courses during after-school hours. TPCs are private institutions and attendance at a TPC depends on the students' and families' preference. Typically, elementary school students start to attend a TPC at the seventh grade level and continue to attend for more hours at the eighth grade level in order to perform better on the Secondary Education Institutions Entrance Examination. High school students, similarly, start to attend a TPC at the beginning of their high school studies (ninth grade level) and continue to attend until the end of high school (11^{th} grade level) to score higher in the Student Selection Examination. Students who have difficulty in any of the content areas at any level of schooling are generally supported by private tutors who are generally teachers or university students.

Participants

This study was conducted with two groups of participants who studied or were studying at the same teacher education program in 2003 and 2004. The first group of participants consisted of a total of 20 preservice teachers who were studying as 2^{nd}-, 3^{rd}-, and 4^{th}-year students at the EME program towards the end of spring semester 2004. Preservice participants were interviewed only in 2004. The second group was formed by 12 first-year (inservice) middle school mathematics teachers who graduated from the EME program in 2003. These participants were interviewed both in 2003 when they graduated from the program, and in 2004 when they completed their first-year as a formal teacher. More information about the participants is given in this section.

The two different groups of participants were associated with the two primary research questions. The first primary research question and its associated subquestions were related to the preservice participants. The second primary question and its associated subquestions were related to the first-year participants of the study. The interviews with the two groups of participants were the data sources to investigate the research questions. The instruments and the methods of data collection and analysis are explained in further sections.

In addition, an Assistant Professor from the EME faculty who had been teaching in the program since 2000 was also interviewed. Although the professor was interviewed, findings from his interview data was used to support results derived from the preservice and inservice participants' interview data.

Preservice Teachers

Twenty preservice teachers participated in the 2004 study. Among them, 5 were 2nd-year students, 7 were 3rd-year students, and 8 were 4th-year students. Table 4.1 shows the number of participants based on year level and gender. The numbers in parentheses show the total number of students in the entire teacher education program in the specified year level.

Table 4.1

The Number of the Preservice Teacher Participants According to Year Level in the Program and Gender.

	2nd-Year	3rd-Year	4th-Year
Female	4	4	7
Male	1	3	1
Number of Participants (Total Number of Students in Program)	5 (37)	7 (38)	8 (38)

These participants were selected among the students who volunteered to participate in the study based on accessibility and students' free time.

First-Year (Inservice) Teachers

Twelve first-year teachers (7 female and 5 male) participated in the study first, when they graduated from the EME program in 2003 and then, at the end of their first-year as a teacher in 2004. Table 4.2 shows the number, gender, and the teaching contexts of the first-year teacher participants. The characteristics of the teaching contexts were described above.

Table 4.2

The Number, Gender, and the Teaching Contexts of the First-year Teacher Participants.

	Private Schools	Public Schools	Graduate School
Female	3	4	0
Male	1	3	1
Total	4	7	1

These 12 participants were selected from the 28 graduates of the EME program in 2003, who were actually the first graduates of the program.

The inservice participants completed their first-year as a formal teacher in different contexts at the time of the dissertation study. Most of the participants who were placed in public schools were teaching in rural settings or small towns. One inservice teacher obtained a position as a graduate assistant in the EME program after one semester of teaching in the public school system.

Professor in the EME Program

Dr. C. (pseudonym) who was a professor in EME program was interviewed in 2004. He was teaching various courses as the only professor with a mathematics education focus in the program at the time that both 2003 and 2004 studies were conducted

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conducted. All participants in this study took at least one course from Dr. C. during their studies in the EME program.

Instruments

A total of three semi-structured interview protocols were used in this study. Table 4.3 shows the interview protocols used to investigate the primary research questions. A fourth interview protocol was used to gain information about the faculty's perspective on the effect of the EME program on the program students' beliefs.

Table 4.3

Interview Protocols Implemented in Relation to the Primary Research Questions.

Research Question	Data Sources
1. How does the Elementary Mathematics Education (EME) program affect the preservice middle school mathematics teachers' (2nd-, 3rd-, and 4th-year students) beliefs about the nature, teaching, and learning of mathematics?	• 2004 Semi-Structured Interview Protocol for the Preservice Teachers
2. How does the Elementary Mathematics Education (EME) program affect the first-year (inservice) middle school mathematics teachers' beliefs about the nature, teaching, and learning of mathematics?	• 2003 Semi-Structured Interview Protocol for the Graduates • 2004 Semi-Structured Interview Protocol for the First-Year Teachers

Interview protocols are introduced below in relation to the primary research questions they investigated.

First Research Question

Semi-structured Interview Protocol for Preservice Teachers (2004 Study)

This interview protocol was designed to investigate preservice teachers' beliefs about the nature, teaching, and learning of mathematics. The preservice teachers were asked about their ideas on the nature of different types and possible evidences of mathematical understanding, ways of teaching a certain mathematical task, and nature of mathematics teaching. Moreover, they were asked about the possible effects of previous policies that they have been exposed to, such as high school type, and the possible perceived effects of the EME program on their mathematics-related beliefs. The interview contained 32 main questions. Follow-up questions were also asked to explore the emerging issues during the interviews. Table 4.4 shows the main concepts and examples of interview questions related to the main concepts. A more complete description of the interview protocol is given in the Appendix C.

Table 4.4

Main Concepts in the Preservice Teacher Interview and Selected Questions (2004).

Main Concepts	Example Questions
Nature of Mathematics	• What is mathematics for? • What does it mean to know mathematics? • Can you tell me what a "mathematical concept" is? • How do you know that a student has understood a mathematical concept?
Teaching Mathematics	• Why do we teach mathematics? • What are the types of knowledge that a mathematics teacher should have? • What will be your main purpose in teaching mathematics in the future?
Attitudes	• Do you enjoy learning mathematics? When? Why?
Policies	• Do you think that the knowledge and skills you gained in the program will be sufficient for your teaching? • How would you define teaching as a profession before you started studying in this program?

Interviews with the preservice teacher participants were generally completed in 90 minutes.

Second Research Question

Semi-Structured Interview Protocol for the Graduates (2003 Study)

Semi-structured interviews were conducted in 2003 with the first-year teacher participants of 2004 study when they completed in the 4th (the final) year of the program. The 2003 interview protocol aimed to investigate program graduates' mathematics-related beliefs. The effects of EME program and some other factors such as (high school education and national examination policy) on their beliefs before they started inservice teaching were also investigated. Table 4.5 shows the main concepts investigated through the interviews and the main questions under each concept.

Table 4.5

Main Concepts in Graduates' Interview and Main Questions for Each Concept (2003).

Main Concepts	Example Questions
Nature of Mathematics	• What is mathematics for? • What does it mean to know mathematics? • Can you tell me what a "mathematical concept" is? • How do you know that a student has understood a mathematical concept?
Teaching Mathematics	• Why do we teach mathematics? • What are the types of knowledge that a mathematics teacher should have? • What will be your main purpose in teaching mathematics in the future?
Attitudes	• Do you enjoy learning mathematics? When? Why? • Do you enjoy teaching mathematics? When? Why?
Policies	• Do you think that the university entrance examination affected your way of studying mathematics? How? • Do you think that the courses you have taken in this program are useful for your profession? Why?

The participants were asked questions about how they perceived mathematical understanding in relation to the teaching and learning of mathematics. They were also asked questions about the way that the university entrance examination affected their study habits and about the education that they had in the department. The interview contained 23 main questions. Follow-up questions were asked to explore the emerging issues during the interview. Interviews were completed in one hour. The main interview questions in the 2003 interview protocol are given in the Appendix C.

Semi-Structured Interview Protocol for the First-Year Teachers (2004 Study)

The interview protocol for the first-year teachers was a modified version of the interview protocol for the preservice teachers in 2004. Besides the issues that were investigated with the preservice interview protocol, the possible effects of one year of formal teaching experience, school context, classroom context, and the curriculum on the first-year teachers' beliefs about the nature, teaching, and learning of mathematics were also investigated. The interview protocol contained 37 main questions with additional follow-up questions if necessary. Table 4.6 shows examples of additional questions that appeared in the first-year teacher interview protocol under the main concepts. More detail is given in the Appendix C.

Table 4.6

Main Concepts and Additional Main Questions in the First-year Teacher Interview (2004).

Main Concepts	Example Questions
Nature of Mathematics	• Without mentioning name or any form of student data, can you give examples of three particular students who have rich, medium, and poor mathematical understanding and related student behaviors?
Teaching Mathematics	• Are there any pressures or supports that affect your teaching, such as students, parents, school administrators or curriculum? • Which grades would you prefer to teach? Why?

Interviews with the first-year teachers were generally completed in two hours.

Semi-Structured Interview Protocol for Faculty

The professor's view of mathematics teaching, the program's effectiveness in educating teachers, and preservice teachers' beliefs were investigated by an interview protocol including 15 main questions. Examples of interview questions are given below:

- Do you think that program effectively prepares students to be mathematics teachers?
- Can you describe the characteristics of effective mathematics teachers?
- Can you describe the beliefs that a mathematics teacher should have (about nature of mathematics, about teaching and learning mathematics)?

Probing questions were asked during the interview where necessary. The complete interview protocol is given in the Appendix C.

Addressing Beliefs in Interview Protocols

The three belief areas (beliefs about the nature of mathematics, beliefs about teaching mathematics, and beliefs about learning mathematics) which were described in Chapter 2, were addressed through specific questions in 2003 and 2004 interview protocols. The 2004 interview protocol is an extended version of 2003 protocols in terms of the questions addressing belief areas. How each belief area is addressed through the interview questions in 2004 study will be explained here in detail. The question numbers are based on the way they appear in the 2004 preservice interview protocol. Additional questions in the 2004 inservice interview protocol are given with the question number they appear (see Appendix C).

Beliefs about the Nature of Mathematics

In order to address beliefs about nature of mathematics, participants were asked about how they would consider mathematical knowledge, knowing and understanding mathematics, and the nature of mathematical problems and problem solving. Examples of questions that addressed participants' beliefs about nature of mathematics are given in

Table 4.7

Examples of Questions in 2004 Study Addressing Beliefs about Nature of Mathematics.

	Questions
Preservice Protocol	Q1. What is mathematics for? Q2. What does it mean to know mathematics? Q4. Can you tell me what a "mathematical concept" is depending on your own ideas? • What is a "mathematical concept" for you? • Can you given an example of a question that asks a "mathematical concept"? Q5. How do you know that one of your students has understood a mathematical concept? Q8. Can you tell me what a "mathematical problem" is depending on your own ideas? • What is a "mathematical problem" for you? • Can you give an example of a "mathematical problem"? Q11. How do you know that one of your students has developed a mathematical understanding?
Inservice Protocol	Q15. Without mentioning name or any form of student data, can you give examples of three particular students who have rich, medium, and poor mathematical understanding and related student behaviors?

In these questions, the ways participants described the nature of mathematical knowledge (such as isolated rules or logically connected pieces of knowledge), knowing mathematics (such as reaching correct answer or building logical connections), and the nature of mathematical problems (such as questions that could be solved by mathematical operations or a situation which had no immediate solution) mostly included expressions parallel to the belief statements in the framework. Therefore, it was concluded that interview questions were mostly useful in detecting participants' beliefs about nature of mathematics. Participants' responses to the questions about the nature of mathematics are given in Chapter 5 and Chapter 6.

Beliefs about Teaching Mathematics

Participants' beliefs about teaching mathematics were addressed through the questions, which mostly asked about their preferences in teaching mathematics and the perceived role of the mathematics teacher. The examples for questions addressing beliefs about teaching mathematics are given in Table 4.8.

Table 4.8

Examples of Questions in 2004 Study Addressing Beliefs about Teaching Mathematics.

	Questions
Preservice Protocol	Q13. Why do we teach mathematics? Q14. What are the types of knowledge that a mathematics teacher should have? • Can you make a list of / categorize the types of knowledge that a mathematics teacher should have? a. Why do you think that a mathematics teacher should have these types of knowledge? Q15. What will be your main purpose in teaching mathematics in the future? Q17. What are your strengths in teaching mathematics? Q18. What are your weaknesses in teaching mathematics?
Inservice Protocol	Q16. Can you plan one or a series of lessons (depending on your preference) on a particular topic which reflects your conceptions of mathematical understanding, without considering other pressures such as material availability and time allowed for that particular topic in the curriculum for one of your classes or a class of 30 students?

Participants' responses to these questions about their preferences in teaching (such as demonstrating rules or using manipulatives) and how they would consider a teacher's role in the mathematics classroom (such as explaining rules and their implementation in detail or guiding students in their learning) indicated their beliefs that were detectable through using the framework. In other words, the interview questions were mostly sufficient in capturing participants' beliefs about teaching mathematics. Examples of participant responses are presented in Chapter 5 and Chapter 6.

Beliefs about Learning Mathematics

Learning beliefs of participants were mostly detected by the third question in 2004 interview protocols, as given in Table 4.9.

Table 4.9

Examples of Questions in 2004 Study Addressing Beliefs about Learning Mathematics.

	Questions
Preservice & Inservice Protocols	Q3. What does it mean to learn mathematics? • How is mathematics learned? • How did you learn mathematics? • How do you think a student should study mathematics in order to learn it?

The responses to this question (such as solving a lot of questions or trying to relate new knowledge to the existing knowledge) indicated that the question was effective in identifying their beliefs about learning mathematics.

In addition to Q3, participants' beliefs about learning mathematics were detected in their responses for questions about teaching (see Table 4.8). Participants mostly compared teacher's role and students' role in the classroom or mentioned how they would prefer to teach mathematics in relation to the way students learn as a response to teaching questions. For example, while responding to the question about her perceived weaknesses in teaching mathematics (Q25), P7 claimed that *"[...] there [were] several ways to solve a problem and students should be able to see these [ways]" (P7, Q25,* *2004)*. This indicated that for her, students should be able to see the different ways to reach a solution, which was parallel to a Level 2 learning belief statement in the framework. Therefore, questions about teaching mathematics also generated responses about learning mathematics and were effective in capturing participants' beliefs about learning mathematics. Participants' responses are provided in Chapter 6 and Chapter 7.

Although the questions in especially 2004 interview protocols were found to be sufficient in detecting participants' beliefs, data analysis provided some potentially useful ideas that might be used in the possible future implementations of the interview protocols. The interviews would have been more effective in capturing participants' beliefs if they had included more concrete examples such as Q12 (see Appendix C) on which participants would work and comment on a student misconception, considering the classroom context. Concrete examples would have helped participants express their beliefs about how mathematical knowledge would be organized and how teaching and learning should occur in classroom contexts.

Data Collection Procedure

The data for this study was collected in Turkey in May-June 2003 and May-July 2004 through interviews. The data collected in 2003 was used to investigate the second research question whereas the data collected in 2004 was used to investigate both the first and second research questions. All interviews were conducted in Turkish and audiotaped. Since the language of instruction was English at METU and the students were considered to have a certain level of English proficiency, some questions were also asked in English in order to reduce the change or loss of meaning in translation. Since a part of 2004 data collection procedure was related to the 2003 data collection, these procedures will be explained in terms of years they were conducted.

2003 Study (Data Collection)

The data in 2003 was collected through interviews in with the 4th -year[5] EME program students. The 4th-year students were visited towards the end of the 2003 spring semester (May 2003) at the end of a class after the professor left the room. They were informed about the study and asked whether they would like to participate. It was indicated that participation was voluntary, the results of the study would not be shared with any of the program faculty, and their participation would have no impact on their course grade.

Among the 28 4th-year students, seven female and five male students were chosen to be interviewed among the volunteered students based on their accessibility and free time. The interviews were conducted in May-June 2004 in places where the participants preferred to be interviewed, and in one-on-one settings. It was emphasized before and during the interview that there were no right answers for the interview questions and their beliefs and ideas about mathematical understanding and mathematics teaching and learning were considered as important. The participants were given as much time as they asked to think about the questions and were allowed to skip questions if they did not want to respond at that time. They were also ensured that they could quit the study at any time. Participants were asked the skipped questions at the end of the interview, and they were also allowed and encouraged to answer any skipped questions at any point during the interview.

[5] Recall that the EME program is a four-year program.

2004 Study (Data Collection)

The data in 2004 was collected through interviews in with the 2^{nd}-, 3^{rd}-, and 4^{th}-year EME program students, the first-year teachers who participated in the 2003 study at the end of their 4^{th}-year in the EME program, and the professor. The program students were visited in their courses towards the end of the 2004 spring semester (May 2004). They were informed about the study after the professor left the room and they were asked if they would like to participate. The students were ensured that the participation was voluntary, the results of the study would not be shared with any of the program faculty, nor that their participation would have an impact on their course grade.

Twenty students (15 female and 5 male) were selected among a total of 113 students who were studying in their 2^{nd}-, 3^{rd}-, and 4^{th}-year at the EME program (see Table 4.1). The interviews were conducted in May-June 2004 in participants' preferred one-on-one settings. The participants were ensured before and during the interview that there were no right answers for the interview questions and the research's interest was on their beliefs and ideas about mathematical understanding and mathematics teaching and learning.

All of the participants of the 2003 study agreed to participate in the 2004 study at the end of their first-year as a teacher. They were interviewed in June-July 2004 in the one-on-one settings they preferred. The first-year participants were indicated that the interview questions had no single correct answer and the study's interest was their beliefs and experiences regarding the nature, teaching and learning mathematics. They were ensured that the raw data they provided would not be given to their school administrators or any MNE officer.

The professor in the department was interviewed in 2004 in his preferred one-on-one setting. He was ensured that his interview data would not be shared with other program faculty and the study's interest was his views about the effectiveness of the program and program students' and graduates' beliefs.

All of the participants in 2004 study were given the amount of time they required to respond to the questions during the interviews. They were ensured that they could quit the study at any time or skip any questions that they did not want to or did not feel ready to answer. The questions that they preferred to answer later were asked at the end of the interview.

Data Analysis Procedure

The data analysis was conducted in order to identify each participant's mathematics-related beliefs, levels of these beliefs, and major factors that seemed to affect participants' mathematics related beliefs. The change of level of beliefs through the program and first inservice year were investigated in order to detect key experiences in the program that might have caused change in belief levels.

The data was transcribed and coded by the researcher and a second coder in order to reduce bias in data analysis and to increase the reliability of the results. The recruitment and the training of the second coder are explained in the next section (Quality of the Research). The interview transcripts were prepared so that the coders would not see the names of the participants. Both coders worked on the same data at the same time and coded the data using the framework described in Chapter 3.

The professor's interview transcript was not coded by using the data analysis framework used for the preservice and inservice interviews. His interview transcript was read several times by the researcher in order to gather the emerging themes such as the impact of the EME program courses on program students' beliefs, the nature of the EME courses, and insufficient experiences in the EME program. These themes were used to support findings from the inservice and preservice data.

The two major phases of data analysis, identifying belief levels for each participant and identifying factors that impacted each participant's beliefs will be described in this section in detail.

Identifying Belief Levels

In order to identify the belief levels for each participant, both coders studied the framework and discussed it in depth to understand the characteristics of the levels. These discussions prepared the coders for detecting belief statements in transcribed interviews. During the data coding, first, the coders read the interviews and searched for the belief statements addressed in the framework. Then, in the second step, coders categorized the belief statements as nature belief, teaching belief, or learning belief. Finally, in the third step, they decided on the level of belief statements and final level of each participant's belief levels in different belief areas. These steps are explained below in detail through examples. Certain difficulties appeared during the data analysis and how they were managed will also be explained here.

Detecting Belief Statements

In this step, first, the coders read each participant's interview transcript and individually underlined the belief expressions. The major indicators of belief statements were keywords that appeared in the belief statements of the framework. For example, "logic" and "connected" in the Level 1 belief statement "Mathematics as a static but combined body of knowledge, in which there are structures and truths connected to each other by logic and meaning" were keywords for identifying P1's expression *"knowing mathematics is knowing the meaning of mathematics, which is the logic that we form in nature or life, the numbers, and the relationship between the numbers" (P1, Q2, 2004)* as a belief statement.

Once the coders underlined the belief statements individually, they compared identified belief statements to see if the statements were the same or not. When two coders found different belief statements, coders engaged in a resolution discussion. Initially, coders discussed the existence of a keyword or keywords in participant's expressions. When coders could not find any keywords, coders agreed that the expression should not be considered as a belief statement. This step of data analysis was completed with full consensus of the coders for each participant.

Categorizing Belief Statements

After coders identified belief statements for each participant, the next step in data analysis was to categorize the statements as nature, teaching, or learning beliefs and deciding on the level of the belief statements. For example, in P1's expression quoted above, P1 referred to knowing mathematics. Since knowing mathematics was addressed under beliefs about nature of mathematics, coders initially considered this statement as a nature belief statement. Additionally, coders used a Level 1 belief statement in the framework (as indicated above) as a reference to detect P1's belief statement. Therefore, the belief area for his statement was decided as nature of mathematics and the level of this belief statement was Level 1.

Even though coders considered keywords as references to detect belief statements and then belief levels, coders had some difficulties in categorizing participants' belief statements. One particular difficulty was deciding whether a specific belief statement in an interview was addressing teaching belief or learning belief. For example, P1 claimed that students' mathematical understanding could be improved by *"[providing them] with situations whose solutions [would not be] familiar to them" (P1, Q11, 2004).* Coders considered this claim in two ways. First, coders considered P1 as addressing that students would be able to learn better when students deal with situations that they have no immediate solution, mostly because the interview question was asking students' behaviors. And second, coders considered that P1 might be talking about teachers' role in improving students' understanding. The Level 2 belief statement "One should use, as often as possible, problems where the student has to think first, and where the mastery of calculation alone will not lead to the solving of the problem" in the framework helped them to conclude that this was a teaching belief.

Once coders assigned a specific belief statement in the framework to participant's belief statement, coders also identified the level of participant's statement. For P1's teaching belief mentioned in the previous paragraph, the referred belief statement in the framework was a Level 2 statement. Therefore, the coders concluded that the P1's belief statement was a Level 2 belief. The coders completed this step in full consensus.

Deciding on Final Belief Levels

Following the categorization and level assignment of the belief statements, coders proceeded to the last step, which was reaching a decision about each participant's final belief levels in three belief areas. Reaching a decision for participants' final belief levels was often a complicated process. Three major decision processes occurred depending on the frequency of participants' beliefs in each belief level. These processes appeared when (i) participants had beliefs mostly from a single level; (ii) participants had almost equal number of beliefs in a belief area from two different belief areas; and (iii) participants had no beliefs from a belief area. Decision processes are explained here in detail.

Beliefs from Single Level. The majority of participants had belief statements almost totally from a single level. In these cases, coders decided that the most frequent belief level was the final level of a belief area. For example, P2 had four teaching belief statements of Level 1 and one belief statement of Level 2, which led coders to conclude that she had Level 1 beliefs about teaching mathematics. The final belief level decisions for these participants were completed in full consensus of both coders.

Equal Number of Beliefs. A few participants had almost equal number of belief statements from different levels. Two main situations exemplify this. First, some participants had belief statements from all three levels or from Level 0 and Level 2 in a belief area. In these cases, the coders finalized the belief level as Level 1, using Lindgren's (1996, p.114) figure that illustrated the intersection of all three levels and the intersection of Level 0 and Level 2 in Level 1 area. For example, P1 had four Level 2, two Level 1 and one Level 0 teaching belief statements. Coders concluded that his final teaching belief level was Level 1. In the second situation, two participants (P2 and P9) had almost equal number of beliefs from two consecutive belief levels (see Table 6.1). In these cases, since both coders could not decide on the final level of participants' learning beliefs, they indicated both levels for the participants and interpreted that participants might be in a transition period of moving from one level to the other, considering

Lindgren's figure and Thompson's (1991) characterization of teachers' beliefs that addressed the existence of beliefs from different levels during a transition period. The final step of data coding in these cases was also completed in full consensus.

No Belief Statements. A few participants did not articulate much in a belief area so that no belief statements were detected. In these rare cases, the coders discussed how the participants described the nature of mathematical knowledge, teaching, and learning mathematics and which level these descriptions might match. An example for this case might be P10. P10 did not have explicit expressions about the nature of mathematics in the 2004 interview that would have a complete match with a belief statement in the framework. But she claimed that knowing mathematics was *"solving mathematical problems. Even when it is not with x's and y's [...] but it might be by using a piece of mathematical knowledge and reaching the result" (P10, Q2, 2004)*. Since beliefs about problem solving and knowing mathematics were included in beliefs about the nature of mathematics, coders concluded in the previous steps that this expression was a nature belief statement. However, the level was not clear for coders as P10's expression seemed in between Level 0 and Level 1. When coders looked for additional expressions in P10's transcript to finalize the level of her expression, they found out that P10's example of an elementary school problem addressed simple calculations and she could not articulate on the nature of a higher level mathematical problem. This helped coders to conclude her final nature belief level as Level 0. Coders decided on the final levels of these participants in full consensus.

A sample data coding is given in Appendix D along with a transcribed interview and the coding sheet. The framework for analyzing the interviews was described in depth in Chapter 3.

Identifying Factors

The 2003 study provided some clues about the factors that might have impacted inservice participants' mathematics related beliefs when they graduated from the EME program. In the 2003 study, inservice participants were encouraged to talk about the impact of some of the courses in the EME program on their views about mathematics teaching. Inservice participants also discussed the ways they worked with the students in informal teaching environments. These clues were used to improve inservice and preservice interview protocols for 2004 study. Additionally, depending on the literature that addressed the impact of first-year teaching contexts on beginning teachers (e.g. Veenman, 1984), factors such as students and curriculum pace were addressed in inservice interview schedule in 2004. During the data analysis, the factors that impacted participants' beliefs were mostly detected through their responses to the questions and were noted on the space provided for factors in the coding sheet (see Appendix D).

Table 4.10 gives the examples of questions in 2004 interview protocols for preservice and inservice participants about the factors in preservice training and first-year teaching that might have impacted participants' beliefs.

Table 4.10

Examples of Questions in 2004 Interview Protocols Targeting Factors Impacting Beliefs.

	Interview Questions
Preservice Training*	Q16. Do you have any teaching experience? In which ways and for how long? Q27. Do you think that the courses you have taken in this program are useful for your profession? Why? a. What are the courses that you would like to have? b. What are your expectations from the professors in your program during the courses? c. Do you think that the courses would be different if you had another instructor?
First-Year Teaching	Q13. Do you think that your ideas have changed since you graduated and started teaching? What has affected your ideas? Q22. Are there any pressures or supports that affect your teaching, such as students, parents, school administrators or curriculum? • Do you think that you would teach more effectively if any one or more of these factors had changed? Why and in what ways? Q35. How would you define teaching as a profession before you started teaching as a formal teacher? • How have your ideas changed about teaching profession?

* These questions were also included in 2004 inservice interview protocol.

There were differences in the detail that inservice and preservice participants' responses included. Inservice participants mentioned factors more frequently, explicitly, and in detail. They were mostly aware of what they have been affected by in the 2004 study, such as curriculum rush and informal teaching experiences, an awareness which was not common in the 2003 study. Inservice participants also mentioned factors that emerged from the preservice years and first-year teaching in their responses to other interview questions. For example, while responding to the question about her perceived weaknesses in teaching mathematics (Q25 in 2004 Inservice Interview Protocol, see Appendix C), P10 claimed that:

> *"[T]eaching in a classroom is different. During private tutoring, if you realize that you don't really know the concept, you can open [a book] ...*

You don't really have to make [mathematics] enjoyable and give real-life examples ... Since you are expected to make [the student] solve many questions, you can't really consider [private tutoring as an experience] ... Or the classroom presentations [in the EME program, do not really count as a teaching experience]" (P10, Q25, 2004).

This claim helped the coders to consider a possible limiting impact of private tutoring on P10's beliefs and teaching during her studies in the EME program. Since the study also investigated the perceived impact of factors on participants' beliefs, P10's awareness was considered as evidence of the impact. Preservice participants' responses were mostly not as detailed as inservice participants' responses. The factors that impacted their beliefs were detected through their responses to the specific interview questions targeting factors.

All major factors were detected during the data analysis in which participants' belief levels were identified. The factors were also detected in consensus with the second coder.

Quality of the Research

Issues that underlie the quality of research seem important to address here in order to present the reasons for the methods of inquiry used for this study. Miles and Huberman (1994) refer to these issues as the practical standards that help in judging the quality of the conclusions drawn from the research. There are contrasting views about the applicability of the quantitative research terminology and methods, such as reliability and validity, to the qualitative research (for a detailed discussion, see Golafshani, 2003). While reliability and validity are issues that more typically ensure the quality of quantitative research, the efforts and the skills of the researcher address the quality of qualitative research. Moreover, reliability and validity are generally not discussed separately in qualitative research but rather terms such as "credibility" or "trustworthiness" are suggested in order to address both reliability and validity (Golafshani, 2003). Similarly, Bogdan and Biklen (1998) do not suggest use of the term "triangulation" to address the multiplicity of data sources, researchers, or theoretical approach in order to strengthen the results of the study, but they rather suggest explaining what has been done to have more accurate data. Considering that terms such as reliability, validity, and triangulation have several different approaches in the qualitative research paradigm, the quality of the research will be described under the term "credibility" to address them all.

Credibility

In this section the researcher's role and attitude in the data collection and analysis process, convergence between multiple coders' accounts, limitations that were caused by the data analysis framework and how they were handled will be explained. Moreover, the reasons of having single data type and the measures taken during the data collection process to reduce this disadvantage will be explained in detail.

Researcher's Role

The data of this study is gathered from two different groups of participants: Preservice teachers studying in the EME program in 2004 and inservice teachers graduated from the same program in 2003. My relationship to inservice participants was different then the relationship I had with the preservice participants at the time of the 2004 study. The difference was due to the close contact I had with inservice participants when they were studying at the EME program. Inservice participants and I had established a friendship through my three years of advising them for their academic progress in the EME program. I conducted both extracurricular and recreational activities for them during my assistantship in the Department of Elementary Education. Moreover, I was a teaching assistant for their pedagogical content knowledge courses in the first three years of their studies in the EME program. This impacted the study in terms of the depth and width of the interview data they provided for me especially in 2004 study. Inservice participants were more motivated to provide me with longer and detailed responses about their preservice and first-year practices most probably due to the friendship we established and their willingness to help me in my study.

My relationship to the preservice participants was, however, not that close and mostly in a more formal way. I met almost all 2nd-year and 3rd-year participants for the first time during the 2004 study. Fourth-year participants and I knew each other but they were not close as inservice participants were. Although I tried to comfort preservice participants before and during the interviews through casual conversations about daily issues, some participants were not as motivated as others in providing me with responses to the interview questions most probably due to the lack of sufficient pre-existing communication. Another reason for short responses might be the lack of experience in the program especially for the 2nd-year and 3rd-year participants.

In order to comfort all of the participants during the interviews, I tried to ensure the confidentiality of the data and I repeated several times that there were no correct answers for the questions. When they asked for approval of their answers, I indicated that my interest was what they believed or thought and I was not judging their answers. The participants were interviewed where they felt comfortable in terms of context, transportation, and timing so that their answers would not be in a rush. During the interviews, I tried to express what I had understood from the participants' responses to them, when the responses were not clear. I asked them whether I understood their point correctly or not. If they claimed I did not understand it fully or correctly, I asked them to correct my interpretation. I generally summarized participants' responses with one or two sentences before moving to the next question and they generally approved.

The interview schedules for both preservice and first-year teachers had questions related to the course instructors in the program or people in the school contexts (for first-year teachers), where participants might have negative comments. I was expecting these negative comments as a result of my interaction with especially the inservice participants, but I did not force them to report to me such information. In situations where there appeared a need to express the name of a faculty in the college, I suggested to them to name the course instead of naming the instructor, if they did not feel comfortable in naming the instructor. Almost all participants named both the instructor and the course, which might suggest that participants considered my approach as confidential. In other words, my role in the department did not affect the way that participants answered the interview questions about the program effect. Rather, the participants perceived the interviews as an opportunity to anonymously express the issues related to the EME program or the educational system in general (including the first-year participants' teaching contexts) since they did not want to express them publicly.

The difference in the amount of the data gathered from inservice participants and that of preservice participants might have impacted the results, conclusions, and interpretations of the present study. Moreover, since I was once an insider in the EME context and then on the border of being an insider and an outsider, I was aware of reaching subjective conclusions and interpretations. However, being an insider also provided me with clues for interview questions and supporting evidences for investigating participants' beliefs, and knowledge of general tendencies in the EME program. The insider knowledge has always been a motivating issue for me and helped me to organize my results and conclusions.

Nature of Data

Miles and Huberman (1994) addressed the main problem in qualitative data analysis as the "selectivity." It is impossible to get all data for a study since instrumentation, data collection procedure, and the form of the data are selective. For example, in the case of interviews, the transcription eliminates the clues, such as mimics, from nonverbal data. Beliefs are unavoidably investigated through inferences from what people say, intend, and do (Pajares, 1992) where even mimics or tone of the voice might help. However, these are generally eliminated and data sources for investigating beliefs are considered as either verbal responses to questions with abstract levels of thought (Thompson, 1992), or written responses to hypothetical tasks or items (Fang, 1996). In this study, the main data source was audiotaped interviews with the participants, and their written and mostly verbal responses to a mathematical task and the teaching of that task. Belief data in the form of verbal responses is selective also in the sense that participants might not always be willing to talk about their beliefs or represent them (Rokeach, 1968) probably because expression of beliefs is mostly influenced by values (Scheibe, 1960). Thompson (1992) claims that a single data source might result in inconsistency between the beliefs and the practices of the teachers. However, studies with multiple data sources like classroom observations, stimulated recalls, and think aloud processes also yielded in inconsistency as well (Fang, 1996).

There were several reasons for having a single type of data (i.e. interview transcripts) in this study. The main reason was the conditions in the study context that limited the availability of additional data sources. For example, in the beginning of the 2004 study, the first-year teachers were asked to provide lesson plans and evaluation tasks that exemplified their own conceptualization of thoughtful mathematics lessons. They hesitated, but did not refuse, since their lesson plans did not reflect their conceptualization but reflected the certain template given by the MNE that they must imitate in writing lesson plans[6]. They also claimed that they generally did not follow the lesson plans in their teaching but conducted their teaching according to the responses from the students, rendering the lesson plans as not particularly useful data source. Observing the first-year teachers' classroom, another alternative data source, required permission from the MNE through a long process of paperwork which must be carried out for 11 different schools in 10 different cities. Since there was limited available time period for the study and there were only single available observer during the research, this option for additional data source was eliminated as well. In the case of preservice participants, most preservice teachers who participated in the study completed their student teaching at the time of the study or were not registered in student teaching, thereby eliminating the possibility of observing their teaching in real-classroom settings.

[6] The yearly inspection of elementary schools includes inspecting new teachers' current and previous lesson plans and observing their teaching. Hence, teachers have to write their lesson plans based on the template provided by the MNE.

The first attempt to reduce the disadvantage of having a single data source was presenting the participants with different situations during the interviews in the 2004 study. Both the first-year and preservice participants were asked about their ideas to re-teach an issue about fractions where students had misconceptions by using actual student work (Q12 in the both 2004 interview protocols, see Appendix C). This helped in understanding the participants' beliefs about teaching mathematics and beliefs about how students learn in actual classroom settings. But this does not fully reflect their practice in the real-classroom context where students with different levels of knowledge and interest exist.

There is no doubt that my investigation of teachers' beliefs would have been potentially richer had I been able to observe teachers' practice. Belief research benefits from a continuous observation of teachers' practice in order see the potential instantiation of teachers' beliefs. Despite the absence of observation data, I feel that my results are useful and valid; instead of observing their beliefs in action, I asked several proxy questions to inservice participants about their actual and ideal practices. Although these interview questions helped me in making better inferences about participants' beliefs, they still did not count as real-classroom observations.

Data Analysis

A doctoral candidate in the Secondary Science and Mathematics Education Program in the College of Education at METU was recruited for conducting the data analysis in order to increase the inter-rater reliability of the results. The second coder was a graduate assistant in the EME program, a native speaker of Turkish language, and was fluent in speaking, writing, and reading English. The second coder was trained about the characterization of beliefs and steps of data analysis by the researcher, who was the first coder. After the data analysis framework was explained to the second coder, the first and the second coder analyzed an interview together to practice coding the beliefs and belief levels. Another goal of the sample coding was to practice reaching full-consensus between the two coders on final decisions of belief levels during the actual data coding. During the data coding the coders tried to identify the belief statements and belief levels based on the data analysis framework. Both coders analyzed the transcribed data with pseudonyms for the participants in order to eliminate the bias.

Although a second coder was recruited in order to reduce the bias in data analysis, categorization of mathematics related beliefs as nature, teaching, and learning beliefs had some limitations for data analysis and interpretation of the results. First, the number of nature beliefs was less than the number of teaching and learning beliefs listed in Thompson (1991) and Lindgren (1996) frameworks. In order to reduce this limitation, Ernest's (1989) model, which was consistent with Thompson and Lindgren frameworks in terms of the way beliefs were considered and teaching and learning beliefs were described, was added to the framework. Still, nature beliefs were not described in detail compared to the teaching and learning beliefs. Moreover, there is only one Level 1 learning belief described in the framework (see Appendix A). This might have limited the belief statement that the coders were able to detect in the interview transcripts, as well as the final levels of beliefs.

Second, categorizing beliefs in three belief areas resulted in difficulty in identifying the area of participants' belief statements. This difficulty appeared when the coders started to code interview data. The coders were more inclined to identify learning belief statements from what seemed to be nature belief or teaching belief statements. Most of the discussions between the coders occurred when, for example, a participant believed that obtaining a correct answer was the goal of mathematics and one of the coders considered that this belief implied the belief that considered reaching a correct answer as the indication of learning mathematics. Although the coders developed more rigorous ways of detecting beliefs and avoiding inferences by considering key words as explained earlier in this chapter, categorization of beliefs in three belief areas and the lack of sufficient belief statements in some of these areas might have a limiting impact on detecting participants' belief statements and the results of the study.

Summary

In summary, the study is limited by three major factors. First, the amount of interview data participants provided depending on my interaction with them limited my inferences for the participants who were more hesitant to talk during the interviews. Second, the data analysis framework might have excluded some of the mathematics related beliefs that participants might have expressed during the interviews. And third, the results are limited to the participants' verbal data and they are not confirmed by their practices. Since belief research has a methodological problem with the validity and the reliability of the self-reported data (Fang, 1996), the results of this study and their interpretations have limited generalizability. However, using a data analysis framework which was effectively used in previous studies and the data coding process with two coders did capture the program students' and graduates' major mathematics related beliefs and the impact of EME program on these beliefs.

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Reporting the Results

Being a personal construct with no common definition, beliefs are not directly observable and must be inferred from people's verbal reports, intentions, and behaviors (Pajares, 1992). For the present study, a definition for and characteristics of beliefs (such as being experience-driven) are identified from the literature and a theoretical framework consistent with the characteristics is employed in order to guide the data analysis procedure. Participants' beliefs are inferred through these guidelines in full consensus of two coders. However, even when individuals claim they believe something they may not believe what they say they believe (Rokeach, 1968). In the case of observing a behavior, individuals are likely to have different beliefs underlying similar behaviors (Kagan, 1992). Hence, it is almost impossible to detect individuals' actual beliefs of which they are not also fully aware for the most of the time.

I use the terms "belief" and "believed" for individual participants depending on the definition, characteristics, the data analysis framework, and the full consensus between me and the second coder. However, I try to use these terms with less certainty especially throughout the results chapter and generally report what participants "seem to believe." I also provide extensive exact quotes which I and the second coder inferred for a specific belief based on the framework. Additionally, I use the terms "central", "centrality", and "peripheral" that I borrow from the Green (1971) referring to the consistency of what participants seem to believe over time. Although most of the time I interpreted the results through exact quotes from the participants, the professor in the

[7] The yearly inspection of elementary schools includes inspecting new teachers' current and previous lesson plans and observing their teaching. Hence, teachers have to write their lesson plans based on the template provided by the MNE.

program, and the literature, I present the concern that my interpretations of the results are likely to be subjective.

Organization of Result Chapters

The following three chapters document the results of the study mostly through participants' paraphrased claims or direct quotes. In order to decrease the loss of meaning in quotes that might have occurred during the translation, at times additional phrases were added to some transcripts. By these additions readability and tense adjustment through the text were also aimed. Table 4.11 shows the examples of additions to participants' quotes and their usage.

Table 4.11

Examples of Specific Additions to Participants' Quotes.

Addition	Usage
The mathematics [that a teacher] uses [in teaching] is not complex	Completing the meaning of the quote Increasing readability
a question that require[d] a solution	Tense adjustment
[D]iscipline is very important	Sentence adjustment
there are both good (high) students	Adding a similar meaning that would clarify the quote
These are all PCK (in his own abbreviation) for me.	My explanation for the quote
[...]	Claims between two statements which are not included in the quote
...	Pause during the interview

There are a few phrases used in the following results chapters in order to improve the flow of the text by simplifying long phrases. The simplified and the original phrases are "nature beliefs" simplifying "beliefs about the nature of mathematics"; "teaching beliefs" simplifying "beliefs about teaching mathematics"; and "learning beliefs" simplifying "beliefs about learning mathematics."

The result chapters are organized according to the order of the research questions. Chapter 5 answers the first research question concerning the preservice participants' mathematics related beliefs and the crucial experiences during their studies in the EME program that might have an impact on their beliefs. Chapter 6 answers the first subquestion of the second research question regarding the inservice participants' beliefs. In Chapter 7, the possible impact of the EME program experiences and the first-year teaching experiences on inservice participants (the second and the third subquestions) are documented.

CHAPTER 5

PRESERVICE PARTICIPANTS' MATHEMATICS RELATED BELIEFS

Preservice participants, who were a total of 20 EME program students from the 2^{nd}-, 3^{rd}-, and 4^{th}-year level, were interviewed only in 2004 about their mathematics related beliefs and possible factors affecting those beliefs. The transcript data were investigated in order to understand the nature of their beliefs by implementing the belief framework and to explore the possible changes existing through year levels. Preservice participants' year levels, gender, and level of their mathematics related beliefs are given in Table 5.1.

Table 5.1

Preservice Participants' Year in the Program, Gender, and Belief Levels in Three Belief Areas.

	Year	Gender	Nature	Teaching	Learning
P13	4	F	1	0	0
P14	4	F	0	1	1
P15	4	M	0	1	0
P16	4	F	0	0	0
P17	4	F	1	1	0
P18	4	F	0	0	0
P19	4	F	0	1	1
P20	4	F	0	0	0
P21	3	M	1	0	0
P22	3	F	0	0	0
P23	3	M	1	1	1
P24	3	F	0	1	0
P25	3	M	1	1	0
P26	3	F	1	1	1
P27	3	F	0	0	0
P28	2	F	1	0	1
P29	2	F	0	0	0
P30	2	F	0	1	0
P31	2	F	1	1	1
P32	2	M	1	0	0

After participants' belief levels were detected, certain factors that might have affected preservice participants' beliefs were explored. In this chapter, general characteristics of preservice participants' mathematics related beliefs will be explored first. Then, some year-level variances will be addressed through the impact of certain factors such as EME program courses and informal teaching experiences.

Preservice Participants' Mathematics Related Beliefs

None of the preservice participants in this study had Level 2 beliefs about the nature of, teaching, or learning mathematics. Participants had Level 0 and Level 1 beliefs in the beliefs areas, as can be seen in Table 4.1. The number of participants with Level 0 and Level 1 beliefs were almost equal in the nature and teaching belief areas. Learning was the area in which only 6 of the 20 preservice participants had Level 1 learning beliefs.

Analysis of preservice participant' beliefs showed that there were similarities among the participants' beliefs at the same belief level regardless of the year in the program. In other words, participants from different years had similar Level 1 beliefs and Level 0 beliefs. The similarities in the same belief levels across the participants are described below.

Preservice participants' Level 0 and Level 1 beliefs about the nature of mathematics differed in the way participants considered the construction of mathematical knowledge. Participants with Level 0 beliefs about the nature of mathematics claimed that *"[t]here [were] always determined things in mathematics. [One could] not know them" (P30 (2nd-year), Q3).*" For Level 0 nature belief participants, mathematics was simply a collection of rules that were determined by an outside authority. Moreover, these rules should be known very well through memorization and be implemented in daily life. *"[O]therwise, there [would be] no meaning in knowing mathematics if [one could] not transfer in daily life" (P22 (3rd-year), Q2).* Participants considered knowing mathematics as *"to solve problems...it might be to perform operations, calculations...to solve mathematics questions" (P18 (4th-year), Q2).* On the other hand, Level 1 nature belief participants considered that pieces of mathematical knowledge were logically connected and reasons for these connections were important, as P31 illustrated: *"To think logically...why is this in this way? It should not be "This is in this way [...] Do not object to it!" [...] Now in the proofs that [we] study in college, we ask "Why?"" (P31 (2nd-year), Q29).* Knowing mathematics was not solving a lot of questions, but trying to answer the questions about *"what [the mathematical concept] means, how it is formed, and where else this could be implemented" (P17 (4th-year), Q2).* The difference between Level 0 and Level 1 beliefs were noticeable when participants' claims about the nature of mathematical knowledge and the ways to construct this knowledge were considered.

With respect to the beliefs about teaching, all preservice participants stated teacher-centered practices as effective in teaching mathematics. However, there were differences in participants' consideration of the way teaching-centered practices should take place in the mathematics classroom. Some participants claimed Level 0 beliefs where they stated that the teacher should decide about what would happen in the classroom: *"The best thing to do is to start [from the beginning] and [teach] until the end, without confusing [the students]. To say "These should be done... these should be thought"" (P28 (2nd-year), Q19).* Level 0 teaching belief participants also described correct-response oriented teaching practices in which thinking skills were not emphasized, as P16's descriptions illustrated: *"I mean [I would ask] how many 1/5 does 1 have.. and they would answer. I would ask, now, in how many were we looking for [1/5] ... Maybe they will answer [as] five" (P16 (4th-year), Q12).* These participants assumed that students would most probably answer the questions in the way they, as the teachers, would want them to answer. Participants did not consider that students might have a different answer or might not answer at all.

In contrast to Level 0 participants who believed in highly teacher-centered traditional practices, Level 1 teaching belief participants considered using different approaches in teaching mathematics such as using games and manipulatives, although they placed the teacher as the only decision maker in the classroom. The different approaches were, however, not targeting student understanding at first, but their enjoyment in the mathematics class, as P24 claimed: *"I'll try to teach mathematics as a game so that they won't get bored, and they will understand better if they don't get bored" (P24 (3rd-year), Q17).* Unlike Level 0 participants, Level 1 participants emphasized the importance of understanding and increasing student thinking in the mathematics classroom: *"Mathematics teacher does not only say 2 x 3 = 6. He/she should be able to evoke reasoning in children's mind." (P31 (2nd-year), Q19).* In general, Level 0 and Level 1 teaching beliefs in the preservice group differed in the way the nature of teacher-centered mathematics teaching was described.

Learning was the area in which most of the inservice participants had Level 0 beliefs. Level 0 learning belief participants placed the teacher as the authority who decided about what and how students should learn, as P18 illustrated: *"[Learning at school] should definitely be by the teacher, [and] in the way that he/she shows" (P18*

(4th-year), Q3). Student responsibility was limited to completing the tasks that the teacher assigned, as explained by P21: *"I believe that the students should solve a lot of problems. I believe they should be assigned a lot of homework and exercises" (P21 (3rd-year), Q3).* Level 1 learning participants also held the teacher mostly responsible for student learning, but they claimed that students should study to comprehend the logic behind the mathematical knowledge once the teacher introduced the concepts: *"After understanding [the logic of the concepts that the teacher taught], [the student] has to think about it, [about] why...[The student] has to put that in [his/her] mind by [himself/herself]." (P26 (3rd-year), Q3)*. These participants suggested that students should try to understand the idea behind the solutions to certain questions instead of solving a lot of questions. Level 0 and Level 1 learning belief participants' beliefs differed mostly in the way they considered student responsibilities during the learning process. The teacher was more authoritarian in Level 0 beliefs as he/she was the only decision maker in the mathematics classroom. For Level 1 belief participants, the teacher was still the decision maker in the classroom, but they did assign some responsibility to the students other than solving many questions.

In general, the difference between the Level 0 and Level 1 beliefs were detectable but not dramatic. Level 1 belief participants in the teaching and learning belief areas had similar beliefs with Level 0 participants. However, Level 1 participants believed that different methods and materials should be used for student enjoyment and learning. Level 1 participants indicated that students should have some responsibility in learning mathematics other than answering questions correctly. There seemed to be no radical difference between the content of year-level groups' beliefs.

Year-Level Variances and Possible Factors

A closer look at Table 4.1 showed that there was no pattern of increase or decrease in number of Level 1 or Level 0 beliefs in any of the belief areas as participants advanced through the program. However, there was a decrease in the number of Level 1 nature belief participants in the 4th-year group. Only two 4th-year participants out of eight had Level 1 beliefs about the nature of mathematics. Moreover, the number of participants with Level 1 learning beliefs was quite low especially in the 3rd- and 4th-year level groups compared to the number of participants in these groups. In addition to the lack of significant level increase/decrease pattern, the nature of beliefs in Level 0, and also in Level 1 beliefs across the year levels did not differ much. For example, teaching beliefs of Level 1 teaching belief participants were similar through year levels in the EME program.

One interpretation of the similarities between the 2nd-, 3rd-, and 4th-year students' beliefs in the belief areas might be that the EME program courses did not seem to have a significant impact on preservice participants' beliefs. The relatively low number of participants with Level 0 nature beliefs at the 4th-year level might suggest that the impact of the mathematics courses on participants' nature beliefs even had decreased as the year level in the program increased. The lack of emphasis on the nature of mathematical knowledge in methods courses might impact this decrease as well.

Somewhat interestingly, although 3rd-year and 4th-year participants were still taking or had just completed the coursework about methods of mathematics teaching, some participants mentioned the use of different methods in teaching mathematics (a recurrent theme in methods courses) while others did not make such claim. In general, the

PCK coursework which included methods, curriculum, and educational psychology courses, did not seem to have a considerable impact on the participants' beliefs about teaching mathematics.

Preservice participants' learning beliefs were generally low through the year-level groups compared to the beliefs about the nature of and teaching mathematics. Participants mostly believed that students could learn mathematics only by the help of an authority, who was the teacher in the case of the mathematics classroom. Students had to solve as many questions as they could in order to learn better. This finding, however, was not completely unexpected. The mathematics education professor in the EME program claimed that the program was not providing opportunities for the preservice teachers so that they would develop higher level beliefs about learning. He generalized this to both preservice and inservice teachers: *"They don't have any idea about how environments in which students could learn by themselves could be organized" (Dr. C., 2004, Q6)*. In general, EME program courses did not appear to have an impact on participants' learning beliefs.

Preservice participants had different perceived needs in the program as the year level increased. 2nd-year participants expressed a need for a course in which they would practice teaching in front of their friends during the course: *"I wish we could teach to our friends [in a course]" (P27 (2nd-year), Q27)*. Since 2nd-year participants had not taken the 3rd-year methods course which is organized in this way, they believed that this kind of course would be a good practice before school experience courses. Having taken this methods course, 3rd-year participants believed that they needed more practice of various teaching approaches, as P22 expressed: *"Maybe there should be more practice of [things* *we learned in the methods course]. I haven't taken the other school experience courses yet, maybe those courses have what I am looking for, but things should be practiced, they should be implemented" (P22 (3rd-year), P27).* It seemed that as the year level increased in the program, participants expressed needs for experiences that were to appear the future program courses. Thus, they seemed to be aware of their needs as future teachers.

However, at the end of the program, 4th-year participants expressed the need for some courses they already took in the program. This might suggest that participants did not benefit from the courses as intended. One reason for this seemed to be participants' beliefs about their and professors' responsibilities in the EME courses. Interestingly, 4th-year participants who already completed all the coursework including the school experience courses in the EME program believed that the program faculty should have given them the exact knowledge of *"how a certain [mathematical] concept should be taught" (P20 (4th-year), Q27).* Fourth-year participants complained that they had to learn the methods course contents by themselves through the projects and the presentations, and the professors did not teach sufficiently. These participants believed that they needed more authority in their learning as a college student and they should have been told about what and how to teach mathematical concepts. Thus, perhaps it is not surprising that the learning belief level of preservice participants was relatively low compared to the other belief areas across the year-levels.

Most preservice participants also had informal teaching experiences during their studies in the EME program. Although these experiences did not seem to have a considerable impact on 2nd- and 3rd-year participants' beliefs, it had some influence on the way 4th-year participants considered their teaching practice. Most 4th-year Level 0 teaching belief participants had two years of private tutoring experience and they tended to answer questions in terms of single student. These participants claimed that they did not really know how they would conduct teaching in the actual classroom context. On the other hand, most Level 1 teaching belief participants in the 4th-year group also had informal teaching experiences, but they mentioned the content of the EME program courses during the interviews. The existence of participants with long or no informal teaching experiences in both Level 1 and Level 0 groups suggested that informal teaching experiences did not have a systematic effect on preservice participants' teaching beliefs. Participants' informal teaching experiences generally started one or two years before they started to take methods courses. It might be speculated that, when the participants started to take methods courses, those who were able to connect the course experiences to their existing teaching experiences had Level 1 beliefs. Preservice participants with Level 0 beliefs seemed to lack this connection and preferred to prioritize informal teaching experiences.

Summary

The data gathered from the preservice participants indicated that participants' beliefs about the nature of, teaching, and learning mathematics did not dramatically vary across the year level groups as well as the belief level groups. Preservice participants' teaching beliefs were mostly teacher-centered and their learning beliefs were mostly addressing teacher authority. These beliefs did not have a pattern as the year level in the program increased, but the relatively lower level of learning beliefs among the participants through all year levels was noticeable. The program faculty's comment on inservice and preservice teachers' lack of beliefs about student-oriented learning

environments was also evident in 4th-year participants' beliefs about how they should have been taught in the EME program.

The courses in the EME program and the informal teaching experiences seemed to have some impact on participants' beliefs towards Level 1, but the effect was very limited as could be seen in the difference between the Level 0 and Level 1 beliefs especially in teaching and learning areas. Similarly, informal teaching practices had some very limited effect on the way participants considered teaching and learning mathematics, moving them towards Level 0 beliefs. However, in both Level 0 and Level 1 belief groups there were participants with no informal teaching experience or with considerable private tutoring experiences respectively. This might suggest that the impact of the experiences in the informal teaching contexts and in the EME program were mixed and might be related to the way people connect these to their existing experiences. It seemed that when participants could not build this connection meaningfully, they prioritized the informal teaching experiences and developed beliefs based on them.

CHAPTER 6

INSERVICE PARTICIPANTS' MATHEMATICS RELATED BELIEFS

This chapter documents the findings from the inservice middle school mathematics teachers' data collected in 2003 and 2004. Inservice participants' beliefs and belief levels when they graduated from the Elementary Mathematics Education (EME) program (in 2003) and when they completed their first-year of teaching (in 2004) were identified and compared. Table 6.1 gives the belief levels of participants' 2003 and 2004 beliefs about the nature of mathematics, teaching mathematics, and learning mathematics.

Table 6.1

Inservice Teachers' Belief Levels on Nature of Mathematics (N), Teaching Mathematics (T), and Learning Mathematics (L) in 2003 and 2004.

	N2003	N2004	T2003	T2004	L2003	L2004
P1	1	1	1	1	1	1
P2	1	1	1	1	1	1-2
P3	1	1	1	1	1	1
P4	1	0	1	1	0	1
P5	0	1	0	0	0	0
P6	1	2	2	1	2	2
P7	0	1	0	1	0	1
P8	0	1	0	1	0	1
P9	1	0	1	1	1	0-1
P10	1	0	1	1	0	1
P11	1	0	1	1	0	1
P12	1	1	1	0	0	0

Some participants had the same pattern of change in the belief areas, as can be seen on Table 6.1. While some participants' belief level did not change in any of the belief areas, some participants had similar changes in the form of increase or decrease in at least one of the three belief areas. Inservice participants' beliefs were described and analyzed in the groups that the change in their belief levels suggested. For example, P7 and P8 formed the "Consistent-Increase Group" since their belief levels increased consistently from Level 0 to Level 1 in all belief areas from 2003 to 2004. In each group, participants' beliefs were investigated and interpreted in relation to the specific teacher education program (Elementary Mathematics Education (EME) program), informal and formal teaching experiences during the EME program, and the first-year teaching experiences in order to identify possible common factors affecting the beliefs.

Inservice participants' mathematics related beliefs were investigated through five groups of change pattern: No-change, consistent-increase, slight-decrease, slight-increase, and mixed-change. In each group, first participants' belief levels and preservice and inservice teaching experiences are described. Then, their beliefs about the nature of, teaching, and learning mathematics are explored and analyzed in relation to their experiences. A detailed summary of findings across all inservice participants will be given in the following chapter.

No-Change Group

P1, P2, and P3 maintained the same Level 1 beliefs in 2003 and 2004. P2 revealed some Level 2 beliefs about learning mathematics, but since she still maintained Level 1 beliefs she was considered in this group. Table 6.2 shows the gender and belief level of participants with their teaching contexts.

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[8] The nature of informal teaching contexts is described in the Methods chapter.

Table 6.2

Gender, Type of Teaching Context, Belief Levels of Participants Whose Belief Levels were not Changed.

	Gender	Teaching Context	N2003	N2004	T2003	T2004	L2003	L2004
P1	M	Public	1	1	1	1	1	1
P2	F	Private	1	1	1	1	1	1-2
P3	F	Private	1	1	1	1	1	1

Despite the similarities in their belief levels, participants in the no-change group were teaching in different school contexts at the time of the 2004 study. P1 taught in a rural public school for a semester before he was hired by the EME department as a graduate assistant during his studies in the EME master's program. While in college, his teaching experiences were student-club teaching for three years and private tutoring for one year. P2 taught in a private school in her first year of teaching. She had two years of private tutoring experience while in college. P3's first year of teaching was in a private school which was opened few years ago and she was the only mathematics teacher in that school. Her college teaching experiences included private tutoring for two years and working in a private middle school curriculum project for one year. All no-change group participants taught middle school mathematics in their school contexts.

Beliefs about Nature of Mathematics

All participants in the no-change group had Level 1 beliefs about the nature of mathematics. More specifically, the participants in this group consistently believed that mathematical knowledge included logical thinking and connections between ideas; they defined knowing mathematics as having systematical thinking and multiple views. The participants revealed similar beliefs in 2003 and 2004, as P1 illustrated:

> *"We can say that knowing mathematics is having the logic [...] [It is] more than knowing the formulas and certain rules... [It is] to have the systematic thinking construct." (P1, 2003, Q2)*
>
> *"First of all, it is to know that logic [...] If we define mathematics as the logic that we created in nature or life, numbers, and relationship between numbers, then knowing mathematics is knowing these." (P1, 2004, Q2)*

Similarly, beliefs about the nature of mathematical problems were quite similar in 2003 and 2004 for no-change participants. For example, P1 and P2 believed in 2003 that reaching a solution through using certain concepts and procedures was the essence of mathematical problems. After completing the first year of teaching in 2004, they believed that mathematical problems were the questions expressed in numbers where (i) connections between the numbers could be built (P1, 2004) and (ii) new information would be reached as a result of existing information in the problem (P2, 2004). P1 and P2 defined a mathematical problem as the context where certain information was connected to each other, and P3, somewhat similarly, framed her beliefs around the unknown or "problematic" character of the mathematical problems. She believed in 2003 and 2004 that a mathematical problem had to be *" a problem for the kids... how can I find, where should I go... he [had] to find other solutions by himself (P3, 2003, Q7)."* For her, *"one should be confused about what to do (P3, 2004, Q8)"* when one initially dealt with a mathematical problem.

Although all three no-change participants maintained Level 1 beliefs in 2004, there were some subtle differences in their beliefs about the nature of mathematical understanding. In particular, P1's beliefs could be considered as falling somewhat lower than P2 and P3's beliefs, even though all three were ultimately rated as having Level 1 beliefs. Evidence for this determination was found in the ways that participants characterized a student with rich mathematical understanding. P1 believed that rich understanding could be seen in a student when he/she expressed interest in mathematics and responded to questions correctly. In contrast, and falling somewhat higher on the belief level scale, P2 and P3 believed that rich mathematical understanding could be seen in a student when he/she expressed knowledge of definitions and important points and connections between the ideas.

Similarly, P1's perception of the usefulness of mathematical content courses in the program was somewhat different than P2 and P3's perception in 2004. All no-change participants believed in 2003 that mathematics courses in the program would be useful for their profession. However, in 2004, P1 believed that the mathematical thinking he gained through those courses could not be integrated into his teaching. In contrast, P2 and P3 believed that they were able to integrate their mathematical understanding in their teaching as P3 explained:

> *"Math courses... Discrete course changed my life. I learned how to think [...] [I use it in my teaching] a lot. I am not using the concepts there, but that kind of... asking the "why" question" (P3, 2004, Q31).*

It seemed that not all the participants in no-change group connected the mathematics they studied in the EME program to the mathematics they taught. All of the participants believed that mathematical content courses were useful in improving their mathematical understanding and they all had similar Level 1 beliefs. However, they had different beliefs about the degree that this mathematical understanding could be incorporated into teaching middle school mathematics. The difference in P1's ideas might be related to his teaching context where he had limited resources. P2 and P3, on the other hand, had a wide range of resources and materials that were available in their teaching contexts. This helped them in teaching mathematics on which their mathematical understanding was reflected.

In summary, despite the differences in no-change participants' college and first-year teaching experiences, participants mostly had similar Level 1 nature beliefs in both 2003 and 2004. One might imagine that participants' beliefs about the nature of mathematics might be shaped by mathematical content courses during their studies in the program. No-change participants' teaching contexts generally seemed to help them to maintain Level 1 beliefs.

Beliefs about Teaching Mathematics

All three participants in the no-change group had Level 1 beliefs about teaching mathematics. Their 2003 beliefs addressed different but closely related issues, particularly indicating that mathematics teaching should include different pedagogical approaches *(P1, 2003)*; in a teacher-centered classroom *(P2, 2003)*; where student differences were considered *(P3, 2003)*. In 2004 these Level 1 beliefs were maintained and expressed in detail where participants reported that mathematics teaching should include: (i) relating mathematics to daily life and using concrete materials *(P1, 2004)*; (ii) making children reach correct solutions by logical thinking *(P2, 2004)*; and (iii) drawing visual representations for students with different levels of understanding *(P3, 2004)*.

These somewhat more detailed views of mathematics teaching in 2004 seemed to have emerged for no-change participants as a result of their first-year teaching. The first year of teaching did not change the level of their beliefs about mathematics teaching but rather seemed to help no-change participants to develop better articulated beliefs in which they provided more details.

The more detailed beliefs in 2004 were also reflected in no-change participants' aims in teaching mathematics. P1 was concerned about pedagogical approaches to teaching mathematics that included daily life connections. He aimed to make students apply mathematics in their everyday lives. Similarly, P2 believed in more teacher-centered practices while considering students' logical thinking, which was consistent with her aim of making students understand the concepts without memorizing them. P3 believed in addressing student differences and she aimed to increase student interest and enjoyment. In summary, the common element in the 2003 and 2004 beliefs about teaching mathematics for no-change participants was the characterization of mathematics teaching as a teacher-centered practice including different pedagogical approaches in the classroom where student understanding was considered.

No-change participants' school contexts seemed to play a key role in maintaining their belief levels and adding more detail to their existing beliefs. Participants claimed in 2004 that they did not feel any pressure from the school administrators regarding their teaching practice. The administrators supported their teaching and the schools tried to provide no-change participants with the resources they asked for, especially in the case of P2 and P3.

Although there was no pressure from the administrators, curriculum did put pressure on no-change participants' teaching. Participants indicated in 2004 that they had difficulty in keeping the same pace with the yearly plan. Part of this difficulty was attributed by participants to the students' missing prerequisite knowledge. No-change participants assumed that the students already knew the previous years' concepts but discovered that many students lacked such knowledge. Parent support to no-change participants' teaching was generally low. Participants claimed that parents only considered students' grades and blamed participants for not teaching well enough so that the students would have higher grades.

Despite the similarities in relationships with administrators and parents, participants had different sets of first-year teaching experiences. P1's first year experiences started in a rural public school where resources were limited. He might have had lower Level 1 teaching beliefs by the end of the school year if he had not quit teaching to work as a graduate assistant for preservice teachers. It seemed that P1 was able to maintain his teaching belief level and reveal more detailed Level 1 beliefs by changing his relative position from being a teacher to a teacher educator and graduate student. P2 and P3, on the other hand, had the support of the administrators and a wide variety of resources during the year which probably helped them to maintain their belief levels. No-change participants seemed to compensate for the various negative factors (such as curriculum pressure and lack of student knowledge) that might have affected their belief levels with different elements (such as administrative support or change of position) in their contexts.

As a result, it could be concluded that no-change participants' Level 1 beliefs about teaching mathematics did not undergo substantive change between the end of the EME program (2003) and the end of the first-year teaching (2004). In fact, these beliefs became more central through their first year experiences.

Beliefs about Learning Mathematics

As was the case with the other two types of beliefs, all no-change participants had Level 1 beliefs in 2003 and maintained the same level in 2004. No-change participants believed in 2003 that in order to learn mathematics, students should be able to: (i) implement their knowledge on different situations (*P1, 2003*); (ii) connect the existing knowledge to the new knowledge (*P2, 2003*); and (iii) comprehend all prerequisite knowledge (*P3, 2003*). Similarly, in 2004 P1 emphasized that students should be able to implement mathematics in any situation, where P2 and P3 believed that comprehending the logic and the concepts through connecting new knowledge with the existing knowledge led to learning.

No-change participants' beliefs about learning mathematics not only remained consistent between 2003 and 2004 but also continued to be well-articulated. P1 believed that mathematics could be learned *"when [the students] create[d] problems by themselves and analyze[d] them" (P1, 2004, Q3)*. P2 and P3 believed that the concepts should be logically comprehended by the students until all details were clear for the students. For example, P3 stated that *"[a] student must start from the lowest step and should go through every step. Or if he had missed a step, then he ha[d] to compensate*

that step" (P3, 2004, Q3). The consistency and wordiness in no-change participants' learning beliefs could also be related to their beliefs about nature of mathematics, as discussed above. Recall that no-change participants believed mathematics involved logical connections between the ideas and they also believed that learning mathematics was about learning the connections and the logical structure. Given that there was no change in their beliefs about the nature of mathematics, it is perhaps not surprising that their learning beliefs also remained the same.

Besides having maintained learning belief levels, no-change participants had learning beliefs consistent with their teaching beliefs. As stated in the previous section, no-change participants believed that the teacher was the main responsible actor for students' learning. Correspondingly and in terms of learning mathematics, participants assigned few roles to the students in the classroom. No-change participants believed that students should learn the connections in mathematics in a teacher-centered classroom. On the other hand, they were aware in both 2003 and 2004 of the fact that not all students were identical. P2 noted: *"You see many different kinds of students, I mean they are all different than you can imagine. Something you don't expect that they will understand is understood and something you expect that they will understand is not understood. You cannot determine it earlier" (P2, 2004, Q13).* No-change participants' beliefs about student differences, which were maintained from 2003 to 2004, fell into Level 1 as well.

No-change participants' Level 1 learning beliefs might be attributable to their students' lack of knowledge in their teaching contexts. They experienced difficulty in teaching mathematics to their students who often lacked previous knowledge. This difficulty possibly resulted in beliefs that assigned less role and responsibility to the

students for their own learning. It seemed that although no-change participants were challenged by the lack of student knowledge in the classrooms, they were able to maintain their Level 1 beliefs about learning mathematics.

Other Changes and Conclusions

Despite the similarities between no-change participants' beliefs in all three belief areas, differences did emerge in participants' beliefs about the types of knowledge that were useful in teaching mathematics and the effectiveness of the EME program in preparing them to teach.

With respect to the knowledge that was useful for teaching, for P1, mathematical content knowledge was the least important type of knowledge in both 2003 and 2004. Rather, P1 emphasized the importance of pedagogical content knowledge:

> *"The mathematics [that a teacher] uses [in teaching] is not complex [...] You have the chance of relating elementary school mathematics to the daily life, not all the time, but most of the time. You have the chance to use concrete materials. These are all PCK (in his own abbreviation) for me and mathematical content knowledge comes later in my area" (P1, 2004, Q19).*

The possible reason for P1's emphasis on PCK might be the influence of his teaching and research in the EME masters program that focused on teachers' pedagogical content knowledge. In contrast, P2 and P3 rated mathematical content knowledge as primary in both 2003 and 2004 since *"[a teacher] could direct the students to different and incorrect things" (P2, 2004, 19)* if she did not have the sufficient content knowledge and *"[a teacher] should think about everything [about a mathematical concept]" (P3, 2004,* *Q19).* These participants referred to their experiences in the classroom where students asked different and unexpected questions and participants' mathematical content knowledge helped them to answer these questions with confidence. No-change participants' experiences in their first-year teaching contexts seemed to affect their beliefs about the priority of different types of knowledge for teaching.

No-change participants also had somewhat divergent views on the effects of the EME program on their preparation to teach. Perhaps not surprisingly, P1 (who indicated that PCK was the most important knowledge for a teacher) also indicated that PCK courses had better prepared him for teaching as compared to content knowledge courses, both in 2003 and 2004. In fact, he indicated that mathematical content courses seemed to be getting less useful as he completed his first year of teaching. And similarly, P2 and P3 (who prioritized mathematical content knowledge over pedagogical content knowledge in both 2003 and 2004) believed in the usefulness of content courses in the teacher preparation process.

No-change participants' similar beliefs were accompanied by parallel needs for what they felt that the EME program might have provided to them in 2004. Participants claimed that they would like to have a course that focused on how to teach the 6^{th}, 7^{th}, and 8^{th} grade mathematics curriculum including specific teaching activities and manipulatives during their studies in the EME program. Although no-change participants believed that there were differences among the student population which required different and perhaps individualized teaching approaches, they also believed that best practices for teaching middle school mathematics concepts did exist (e.g., "the best method that fits teaching fractions") regardless of student differences. These two beliefs (student differences exist, but there is one best way to teach a particular concept) seemed contradictory. A possible reason for the presence of two contradictory beliefs might be that they existed in two different clusters of beliefs as Green (1971) explained, although they both seemed to be a result of their experiences in the classroom. Participants believed that their difficulties in dealing with student differences or lack of student knowledge in the classroom could have been eliminated if they had known these best practices.

In summary, belief levels of no-change participants (P1, P2, and P3) had not changed after first-year teaching and remained as Level 1 in all belief areas. Participants' beliefs about the nature of mathematics and teaching mathematics seemed to affect their beliefs about learning mathematics. They seemed to struggle to find ways to teach mathematics when students lacked previous knowledge and certain pressures, such as curriculum rush, were effective. No-change participants believed that the way they conceptualized mathematics could be taught in the classrooms by decreasing student contribution and participation while increasing and prioritizing teacher decisions and authority in the classroom.

Consistent-Increase Group

The belief levels of P7 and P8 increased from Level 0 to Level 1 in all three belief areas after the first year of teaching. The gender, belief level and teaching contexts of participants are given in Table 6.3.

Table 6.3

Gender, Teaching Context, Belief Levels of Participants Whose Belief Levels Were Increased Consistently.

	Gender	Teaching Context	N2003	N2004	T2003	T2004	L2003	L2004
P7	F	Private	0	1	0	1	0	1
P8	M	Public	0	1	0	1	0	1

Although these two participants in consistent-increase group had the same pattern of increase in their beliefs, their teaching contexts were different. P7 taught in a private school in her first year. She had one year of private tutoring experience while in college and completed a double degree program in mathematics during her studies in the EME program[9]. P8 taught in a rural public school in his first year and he had one year of private tutoring and 1.5 years of student club teaching experiences in college. P7 taught middle school mathematics and P8 taught middle school mathematics and high school physics in their first year.

Beliefs about Nature of Mathematics

Consistent-increase participants did not give complete and clear answers to the main and probing questions about the nature of mathematics in 2003. It could be inferred from their answers that their 2003 beliefs addressed (i) knowing mathematics was having sufficient mathematical knowledge (P7, 2003), and (ii) solving many questions was the most effective way of improving mathematical understanding (P8, 2003). After the first

[9] Students in the EME program can have a second degree which is named as "Double Major Degree" in the Mathematics Undergraduate Program by completing extra coursework.

year of teaching, both consistent-increase participants were more articulate on the same or similar questions and provided clearer belief expressions about nature of mathematics. For example, P7 believed that mathematics provided abilities that one could use in daily life. Such abilities included *"analytical thinking [and] approaching issues through different perspectives" (P7, 2004, Q2)*. For P8, advanced mathematical knowledge should be built on fundamental knowledge: *"[In math] each concept has a beginning point. When you know these beginning points, then... level by level... [you] add more on [this beginning point] depending on your level or your knowledge" (P8, 2004, Q3).*

The way consistent-increase participants characterized a student with rich mathematical understanding also reflected an increase in their belief levels to Level 1 in 2004. They believed that some of their students had rich level of mathematical understanding since they were able to comprehend connections between mathematical ideas, as P8 illustrated: *"After I teach a concept, I ask a question which includes connection to another concept. Those students [with rich level of mathematical understanding] can immediately respond in some ways" (P8, 2004, Q15).*

The relative increase in consistent-increase participants' nature belief level was, however, not reflected on their other related beliefs in this category. Both participants had lower level beliefs about the nature of mathematical problems in both 2003 and 2004. Participants characterized a mathematical problem in 2003 as *"the problem that [could] be solved by using mathematics" (P7, 2003, Q7)* and *"a question that require[d] a solution" (P8, 2003,Q7).* Similarly in 2004 they believed that mathematical problems were the contexts where certain operations and procedures could be implemented (a Level 0 sentiment) rather than as the contexts that provided a challenge that required advanced thinking skills (a Level 1 belief). Despite the overall increase in the sophistication of their beliefs about the nature of mathematics, consistent-increase participants persisted with Level 0 beliefs about the subcategory concerning the nature of mathematical problems.

Although consistent-increase participants generally had similar Level 1 beliefs about mathematical understanding and similar Level 0 beliefs the nature of mathematical problem in 2004, their beliefs regarding the usefulness of mathematics courses were somewhat different. Both participants believed that the mathematics courses improved their thinking skills in 2003 and 2004. However, they had different beliefs about the usefulness of these thinking skills in teaching mathematics in 2004. P8 did not believe that the thinking skills learned in mathematics courses could be incorporated into teaching middle school mathematics, whereas P7 believed in and illustrated the usage of these thinking skills as: *"[N]ow I approach [to the problems] in terms of both how to teach and how to interpret in a different way [since I took the discrete mathematics courses]" (P7, 2004, Q10).* This difference in beliefs might be due to the impact of the double major program in mathematics that P7 completed while in college.

In summary, despite the differences that the two consistent-increase participants had in their teaching contexts, they had quite similar and more sophisticated beliefs in 2004. The fact that they had lower level beliefs about the nature of a mathematical problem might suggest that P7 and P8 were still in the process of moving from Level 0 beliefs to Level 1 beliefs about the nature of mathematics at the end of their first year in teaching.

Beliefs about Teaching Mathematics

Consistent-increase participants' beliefs about teaching mathematics increased from Level 0 to Level 1 after the first year of teaching. Participants actually had quite similar beliefs in each year, but the change in the overall belief level seemed to be caused by a definite change in their beliefs about students' role in teaching. Consistent-increase participants claimed almost no role for the students but held the teacher as the only responsible person in the mathematics classroom in 2003. For example, P7's main concern in the class was *"after they understand this, I can give this and give that... Will they be able to understand this example?" (P7, 2003, Q17)* since she located herself as the main information giver in the classroom. After the first year of teaching, however, both consistent-increase participants considered student input in their teaching as important. They claimed that they recognized student responses and implemented different pedagogical approaches to address individual differences in learning mathematics. Although participants believed in the importance of having more student-centered practices in 2004, they still placed the teachers as the main authority in the classroom.

This greater emphasis on student participation seemed to be associated with a shift from cognitive outcomes to affective outcomes in consistent-increase participants' aims. In 2003, participants aimed to increase students' understanding and level of thinking. However, in 2004, their aim was to make students enjoy mathematics and have a positive attitude towards mathematics course, as P8's beliefs illustrated: *"[My first aim is] to make them like mathematics... Or first like me as a person, then have an interest in mathematics, and then to reach a certain knowledge level" (P8, 2004, Q20)*. It was not the case that participants were less concerned with cognitive outcomes; rather, participants believed that once the student math anxiety and dislike of math were eliminated, students could learn better. It seemed that the change in beliefs about how mathematics should be taught might be related to the change in beliefs about how students could learn mathematics. This issue will be revisited in the next section.

The participants in the consistent-increase group had supportive administrators in their teaching contexts. Moreover, unlike P8 who taught in a setting with rather limited resources and no parent support, P7 had many materials and resources available to use in the classroom in her school and she generally had support from parents. Both P7 and P8 frequently mentioned student mathematics anxiety as the most important factor that affected their teaching in the classroom: *"[Students have] a fear for mathematics and a negative attitude. First, these should be erased from their minds" (P7, 2004. Q20).* This suggested that dealing with students' mathematics anxiety possibly caused a change in participants' beliefs and aims, and initiated a new belief that prioritized affective outcomes over cognitive outcomes.

Beliefs about Learning Mathematics

Similar to the results in the other two belief categories, consistent-increase participants' learning beliefs also increased from Level 0 to Level 1 after the first year of teaching. Participants' 2003 beliefs considered students as passive receivers of knowledge and imitators of question solving procedures that the mathematics teacher had demonstrated. Whether or not students successfully received knowledge could be evaluated through examination results. After the first year of teaching, the major change in consistent-increase participants' learning beliefs was an increase in the responsibility that students should have in their learning and the importance of having positive attitudes in this process, as mentioned in the previous section. Consistent-increase participants believed that students should contribute to the learning process by their explanation (P7, 2004) and that students' effort to reach advanced mathematical knowledge would be an indication of learning (P8, 2004).

Having positive attitude and motivation were the pre-conditions for learning mathematics, as P7's beliefs illustrated: *"You have to have [a] positive attitude [towards mathematics]. You have to like mathematics. Additionally, math should be interesting for us... so that we can learn" (P7, 2004, Q3).* However, it was teacher responsibility to motivate the students: *"There is a need for at least one person who can motivate or adapt a student [to mathematics] so that he can learn or understand mathematics" (P8, 2004, Q3).* Participants believed that once students were motivated, they would study the concepts in order to learn.

In summary, having students with mathematics anxiety appeared to have an impact on consistent-increase participants' learning beliefs. Participants believed in 2004 that they were responsible for increasing student attitude towards mathematics and students were responsible for studying once they had positive attitudes.

Other Factors and Conclusions

The participants in the consistent-increase group had somewhat similar beliefs about the types of knowledge that were useful for teaching mathematics and the influence of the EME program experiences on their teaching.

The two consistent-increase participants agreed about the knowledge needed for teaching mathematics in both 2003 and 2004. They believed in 2003 that mathematical content knowledge was more important than PCK for teaching mathematics. In 2004, however, they both believed that PCK was the most important type of knowledge, followed by content knowledge. There seemed to be a connection between consistent-increase participants' beliefs about the types of knowledge and their aims in teaching. When participants had cognitive aims in their teaching such as increasing student thinking in 2003, they prioritized mathematical content knowledge over PCK. In contrast, when they had more psychological aims in 2004 such as increasing student attitude and motivation, they prioritized PCK over content knowledge.

The first year of teaching did not change much in consistent-increase participants' beliefs about the influence of the EME program experiences on their teaching. Both participants believed in 2003 and in 2004 that PCK courses were useful in their teaching. However, they believed in 2004 that more PCK courses should have been offered in the program so that they would conduct better teaching in their classrooms. The need for more PCK courses might be related to participants' change in beliefs about how mathematics should be taught and how students could learn mathematics. Since consistent-increase participants tried to make mathematics more interesting for their students (because of a new-found concern for affect and motivation), they needed more PCK courses that focused on effective mathematics teaching through increasing motivation. This was also consistent with the way they prioritized pedagogical content knowledge over mathematical content knowledge in 2004.

The consistent increase in participants' belief levels seemed to be a result of meeting the students in actual classroom environments. Participants claimed that being in the real-classroom environment with a real student population made everything they learned different once they started to teach. Participants started to make sense of what they had learned in the program after they started to teach in the real-classroom context. They prioritized students' motivation and positive attitude in the mathematics classroom instead of a more dominant focus on increasing content knowledge. Despite the radical difference between the school contexts (in terms of available resources, parents' involvement, and students' socio-cultural and socioeconomic background) and the differences in college teaching experiences, both consistent-increase participants had the same pattern of change in their belief levels. Their perceived needs were also related to their first-year teaching experiences. Consistent-increase participants considered more PCK courses as needs in the program, which was consistent with their rankings in 2004. It seemed that the first-year teaching experience had a strong impact on the change of participants' belief levels.

Slight-Decrease Group

P9 and P12 were considered to be the slight-decrease group since their belief levels decreased to a lower level in at least one of the belief areas in 2004. P9's 2004 belief level in nature of mathematics decreased from Level 1 to Level 0 and her beliefs in learning mathematics indicated both Level 0 and Level 1 beliefs, suggesting a possible future decrease in learning belief level. Her teaching belief level was maintained at Level 1. P12's teaching belief level decreased from Level 1 to Level 0, whereas his nature and learning belief levels stayed the same, Level 1 and Level 0 respectively. Table 6.4 shows gender and belief levels of participants with their teaching contexts.

Table 6.4

Gender, Teaching Context, Belief Levels of Participants Who Had Decrease in their Belief Levels.

	Gender	Teaching Context	N2003	N2004	T2003	T2004	L2003	L2004
P9	F	Public	1	0	1	1	1	1-0
P12	M	Private	1	1	1	0	0	0

P9 and P12 had somewhat different college and first-year teaching contexts but they had similar experiences with the students in their first year, which will be reported in the Beliefs about Teaching Mathematics section. The analysis of their interviews showed that P9 and P12 were cases where similar experiences with the student population resulted in a decrease of belief levels in different belief areas. Hence, it seemed reasonable to report the change in P9's and P12's beliefs separately under the three belief areas (nature of mathematics, teaching mathematics, and learning mathematics) followed by a summary section for each area.

P9 taught middle school and high school mathematics in a small town public school while she was also studying for her master's degree in the EME Master's Program. She had four years of private tutoring experience and one semester of TPC teaching while in college. P9 took most of the courses in the Mathematics double major program during her studies in the EME program, but could not complete this degree due to her commitment to the TPC she was teaching.

P12 taught middle school mathematics in a private school and continued his studies for a master's degree in measurement and evaluation at another university. He had one year of TPC and 1.5 years of student club teaching experiences during his studies in the EME program.

Beliefs about Nature of Mathematics

Although both slight-decrease participants had similar Level 1 beliefs about the nature of mathematics in 2003, P9's belief level decreased to Level 0 whereas P12's belief level remained the same in 2004.

P9. P9 had Level 1 beliefs about the nature of mathematics indicating connections and relationships among the pieces of mathematical knowledge in 2003. She mentioned several times that theorems and their proofs would build relationships between mathematical ideas. Although P9 characterized mathematics as a language in 2004, she could not articulate more on this analogy. Furthermore, she believed that telling the correct step in solving a question was the indication of students' mathematical understanding: *"As a simple example, when we teach the equations, [the student should be able to] tell the order of the operations, perform the operations, and reach the solution by this way" (P9, 2004, Q6).*

The decrease in P9's belief level was also apparent when her beliefs about the nature of mathematical problems were considered. She believed in 2003 that mathematical problems appeared when a new knowledge in mathematics was created through theorems. However, in 2004, her belief level decreased to Level 0 where she defined a mathematical problem as *"something that require[d] an operation" (P9, 2004, Q8).* Despite having lower level nature beliefs in 2004, P9 believed that mathematics courses and especially geometry courses were useful for her teaching.

P12. In 2003 P12 believed that building relationships between mathematical ideas and to *"indicate where things come from" (P12, 2003, Q3)* were crucial in understanding mathematical concepts, which were Level 1 beliefs. He consistently believed in 2004 that understanding the logic behind the concepts in reaching mathematical knowledge was important.

P12 indicated in 2003 that a mathematical problem was the narrative form of certain mathematical operations that required a student *"to symbolize it in order to solve" (P12, 2003, Q10)*. He had more elaborated beliefs in 2004 in that he defined a mathematical problem as a question that students would comment on and discover.

Somewhat interestingly, P12 did not believe that mathematics courses were useful since he *"just memorized and forgot their content" (P12, 2004, Q31)*. Despite the fact that P12 recognized connections and logic behind mathematical concepts, he did not seem to maintain these beliefs when he considered his own education in mathematics. P12's beliefs about the usefulness of the mathematics courses and how he learned their content might suggest a further decrease in his belief level or the peripheral nature of his existing beliefs, as Green (1971) would suggest.

Summary and Discussion

P9 and P12 had unique patterns of change in their beliefs and belief levels in 2004, although their Level 1 beliefs in 2003 were similar as both participants claimed that mathematics was a connected web of ideas. While P12 generally had Level 1 beliefs about the nature of mathematics, mathematical problems, and mathematical understanding in 2004, P9 mostly had Level 0 beliefs in these subcategories. One reason might be the scope of the grade levels that the participants were teaching at the time of the study. While P12 was teaching two different middle school grades, P9 was teaching a total of five different grades in middle school and high school. Preparing lesson plans and materials for five different grade levels at a very early phase of her teaching was probably not easy for P9. It was possible that P9 had less focus on the nature of the mathematics she was teaching and she underemphasized its connected and logical nature.

Beliefs about Teaching Mathematics

Although P9 and P12 had Level 1 teaching beliefs in 2003, they did not have the same level of beliefs in 2004. P12's teaching belief level decreased to Level 0 while P9's belief level remained at Level 1.

P9. The teacher was the main responsible person for teaching mathematics for P9 in 2003. However, students also had some roles in the classroom. She claimed that instead of using already existing teaching materials, she would prefer to produce a teaching material with the students and use it in the classroom.

P9's teaching beliefs and belief level did not change after the first year of teaching. She still believed that a teacher-centered classroom in which students participated in the teaching-learning process would be an effective teaching context:

> *"[The teacher] should be in continuous communication with the students. [...] If there is a concept which is not understood by a certain way, then [the teacher] should explain it in a different way. [The teacher] should always include the students in [the teaching-learning process]" (P9, 2004, Q19).*

P9's aims for teaching mathematics were consistent in 2003 and 2004. She believed that relating mathematics to daily life was an important part of teaching, because students could learn better if they saw the connection between the mathematics concepts and the daily life.

P12. For P12, a teacher should have continuous, friendly communication with the students in 2003 so that their motivation and learning could be increased. Moreover, a teacher should gain student attention during his teaching: *"[The teacher] would do activities that would grab students' attention and also he would put knowledge in these [activities] little by little." (P12, 2003, Q10).*

When P12 was asked in 2004 about how he would plan his teaching to correct a misconception, he described a teacher-centered session in which he told the students about all the steps they needed to solve a question and to perform certain operations, indicating Level 0 beliefs. Although he still aimed for increasing student motivation and having a good communication with the students in 2004, his beliefs became more teacher-centered.

Summary and Discussion

P9 and P12 had similar experiences with and concerns about students in 2004. Both participants claimed that having students who lacked prerequisite knowledge in the classroom was the most discouraging factor in their teaching, as P12 explained:

> *"The only thing that discourages me is the students without sufficient knowledge [...] Because there are both good (high achieving) students and bad (low achieving) students. You come across such a dilemma that you want to give more to the good students, but you know that the low-level students won't be able to get it, so you stop yourself" (P12, 2004, Q22).*

Despite the somewhat similar discouragement P9 and P12 felt in their first-year teaching, their beliefs were affected in different ways. P9 had lower level beliefs about the nature of mathematics, whereas P12 had lower level beliefs about teaching mathematics. The reason might be related to the centrality of their beliefs in belief areas (Green, 1971). It was possible that participants' discouraging experiences (in addition to the other factors such as teaching many different grade levels) affected the belief area where their beliefs were less central compared to the beliefs in other areas. For example, P9's discouraging experiences with students made her reconsider her teaching skills:

> *"The baskets come to the classroom full [...] There is no need for me to say anything ... [The students] try, do something, [and] the baskets are full ... The next day, I don't know what happens, I think there is a hole on the bottom of the basket ... It's empty, but believe me there is nothing left, I cannot even find a sentence [...] I mean, when I see those [incidents where students cannot even do simple tasks] I start to say there is a problem [about] me" (P9, 2004, Q28).*

However, she maintained her Level 1 beliefs about teaching, probably because those beliefs were more central compared to her Level 1 beliefs about the nature of mathematics. Hence, she adapted Level 0 beliefs about the nature of mathematics in order to increase student learning.

Beliefs about Learning Mathematics

Slight-increase participants had different learning belief levels in both 2003 and 2004. P12's learning belief level did not change during his first year of teaching and remained at Level 0. However, P9's Level 1 learning beliefs in 2003 were not completely maintained in 2004 where she had both Level 0 and Level 1 beliefs.

P9. P9 had Level 1 learning beliefs in 2003. She considered students' thoughtful efforts as an important input in producing teaching and learning materials. She believed that relating mathematics to daily life would enable students to learn mathematics better. Since producing teaching materials was actually relating mathematics to daily life for P9, she considered student involvement in this process as crucial for their learning. Although she still believed the value of student efforts in both teaching and learning mathematics in 2004, she started to believe that either memorization or repetition might be a way to learn (a Level 0 belief): *"I mean there is repetition ... Maybe [the student] should try to memorize the rules but memorization does not work. He has to repeat" (P9, 2004, Q3).*

The reason that P9 was simultaneously holding Level 0 and Level 1 learning beliefs seemed to be discouraging experiences that she had with students. She was not able to get any response to her questions about the concepts previously covered by student-centered approaches. Although P9 still believed in the value of students' thoughtful efforts in learning mathematics, the fact that students' efforts did not result in learning, may have made her reveal lower level learning beliefs.

P12. P12 believed in both 2003 and 2004 that solving as many questions as possible was the only key skill to learn mathematics, which was a Level 0 belief: *"Some people can make it, some people cannot [...] Even if I don't know anything, I mean someone who says "I cannot do" can improve himself or herself by solving many questions" (P12, 2004, Q3).* Moreover, P12 also believed in both 2003 and 2004 that having higher motivation and a positive attitude would lead to learning. He seemed to maintain these two beliefs simultaneously by assigning roles both for the teacher and for the students in student learning. P12 believed that students would learn mathematics if teachers would increase student motivation and students would solve as many questions as they could. Although he seemed to assign a role for the students for their learning, that role indicated a Level 0 belief that minimized student effort to solving many questions.

Summary and Discussion

The reason for slight-decrease participants' maintained (for P12) or decreased (for P9) Level 0 beliefs might be the effect of the student population in their teaching contexts, as mentioned in the previous section. Participants claimed that they had difficulty in managing students with different knowledge levels in the classroom. It might be speculated that participants were discouraged when their more student-centered practices did not work in the classroom because of knowledge gaps among the students. Hence, they either adopted more Level 0 beliefs and practices besides their Level 1 beliefs (as in the case of P9), or maintained their existing Level 0 learning beliefs (as in the case of P12).

Other Changes and Conclusions

In order to understand how the slight-decrease participants' first-year experiences affected their mathematics related beliefs, they were asked to categorize types of knowledge needed in teaching mathematics both in 2003 and 2004. P9 and P12 had different beliefs about the essential types of knowledge, but their beliefs were consistent with their aims in teaching.

In both 2003 and 2004, P9 believed that a mathematics teacher should have mathematical content knowledge and should know how to connect this knowledge to daily life, which was consistent with her beliefs about the importance of relating mathematics to daily life in teaching.

Although P12 prioritized content knowledge over good communication skills in 2003, he believed in 2004 that good communication skills were the most important type of skill that a teacher should have, followed by content knowledge. His 2004 ranking was somewhat consistent with his aims in teaching, where he prioritized increasing student attitude and motivation. Having good communication skills were important for P12 since he believed communication skills were the tools he would use to make students enjoy mathematics.

The most effective factor on slight-decrease participants' belief levels could be stated as the "unexpected" classroom reality. Participants had a student population whose previous mathematical knowledge was incomplete and unequal. This had different impacts on each slight-decrease participant's beliefs and belief levels. P9 had a lower level of beliefs about the nature of mathematics whereas P12 had a lower level of teaching beliefs at the end of their first year in teaching (2004) compared to their belief levels when they graduated from the EME program (2003). Although P9 still held mostly Level 1 beliefs about learning mathematics, she had some Level 0 learning beliefs as well. Considering that P12 maintained his Level 0 beliefs in 2004, it might be concluded that discouraging experiences with the students were likely to result in more central Level 0 beliefs about learning mathematics.

Slight-Increase Group

P5 was the only participant who had a slight increase in his belief levels after the first year of teaching. His belief levels in all areas in 2003 were Level 0. In 2004, the level of his beliefs about nature of mathematics increased to Level 1, whereas the other belief levels remained the same. Table 6.5 shows P5's gender, teaching context, and belief levels.

Table 6.5

Gender, Teaching Context, Belief Levels of Participant Who Had Increase in his Belief Levels.

	Gender	Teaching Context	N2003	N2004	T2003	T2004	L2003	L2004
P5	M	Public	0	1	0	0	0	0

P5 taught in a rural public school after teaching at a TPC for one semester in his first year. He had four years of private tutoring and three years of TPC teaching while in college. He was the 15th teacher for that year who was assigned to teach middle school mathematics in his public school. Among those 15 teachers, P5 was the only mathematics teacher.[10] Besides teaching middle school mathematics, P5 was teaching English[11] at the same school and working as the school counselor.

Beliefs about Nature of Mathematics

P5 did not have much to say for the questions about the nature of mathematics in 2003. Although he mentioned that mathematics improved analytical thinking skills, he could not provide clear arguments about the nature of mathematical concepts, procedures,

[10] Recall that the principals generally have the authority to assign teachers to various content areas even if they are not certified to teach the content.
[11] Since the language of instruction at METU is English, graduates of METU are generally assigned to teach English even if they are not certified as English teacher.

or a mathematical problem. The following explanation of the nature of a mathematical problem illustrated this:

> *"[Problem solving] is the method that is followed while questioning or teaching of a mathematical concept. You convert it to a problem and connect to daily life" (P5, 2003, Q7).*

Moreover, the way he would evaluate student mathematical understanding was simply by in-class written examinations.

In 2004, P5 provided clearer explanations for the nature of mathematical problems:

> *"I think that it is the place where daily life is completely integrated into mathematics one to one [...] which provides many different thinking methods to the students. It might be a regular writing, an operation, or only a logical thinking, demonstrating a method... but it is in the problem" (P5, 2004, Q8).*

He addressed logical thinking as a part of a mathematical problem, where the problem was derived from daily life. Moreover, P5 believed that reasons for mathematical procedures should be known by the students. Hence, he made his students always ask "Why?" questions for everything that they did in the mathematics class. These views of a mathematical problem and the emphasis on reasons for mathematical procedures indicated that P5 had an increase in his nature belief level from Level 0 to Level 1.

P5's perception of the usefulness of the mathematics courses in the program also reflected an increase in the level of his beliefs about the nature of mathematics. P5 believed in 2003 that with the exception of the geometry course, the mathematics courses were not useful for teaching middle school mathematics since they were not related to the middle school content. Moreover, these courses were not useful for improving thinking skills for P5. In 2004, he believed that the mathematics courses might be useful for his own thinking, but not for teaching:

> *"[Mathematics courses] improved my speed in mathematical operations and improved my questioning... For me, maybe it is useful in this way. But I did not teach [in middle school mathematics] the rules [I learned] in those [mathematics] courses." (P5, 2004, Q31)*

Although P5 recognized the thinking skills he gained through the mathematics courses in the EME program, he still believed that these courses were not useful for teaching middle school mathematics.

The increase in the level of P5's beliefs about the nature of mathematics seemed to be the result of the change in his teaching context. Since P5 had a lot of TPC teaching experience (3.5 years) prior to his public school teaching, he noticed the difference between the mathematics taught in TPC (which emphasized solving different types of questions in a short time) and the mathematics taught in schools (which emphasized understanding concepts more) when he started to teach in a public school. He claimed that the students in TPC had never asked and the teachers had never mentioned the reasons for mathematical principles. Hence, he tried to focus on reasons for the rules and principles in his public school teaching. However, the effect of TPC teaching on his beliefs could still be seen when his beliefs about the nature of mathematical understanding was considered. He believed that giving the desired answer for a question was evidence of a rich mathematical understanding. This indicated that although P5 realized differences between TPC teaching and public school teaching, he was still affected by his TPC teaching. For him, students' correct answers on questions were an indication of their mathematical understanding.

Beliefs about Teaching Mathematics

Despite the increase in P5's belief level about the nature of mathematics, his teaching beliefs did not change after his first year of teaching. He consistently believed that teaching should be in a classroom where there was an authoritarian environment. He mentioned no role for students in the class and considered teacher authority as priority, as his following phrases from 2003 and 2004 interviews illustrated:

> *"I would like to have discipline [in the classroom] and teach in a disciplined environment." (P5, 2003, Q15)*
>
> *"[D]iscipline is very important for me. In some cases I am really authoritarian." (P5, 2004, Q24)*

Interestingly, P5's aims in teaching in 2003 were to have a student-centered classroom, where he allowed discovery and his method of evaluation would definitely not be exams: *"I evaluate [whether a student understood a mathematical problem or not] in a group work" (P5, 2003, Q8)*. His 2003 aims contradicted his teacher-centered responses to other questions in the same interview where he claimed, *"In my way [of teaching], there would not be so much group work." (P5, 2003, Q13)*. In 2004, he had more consistently stated aims and beliefs in teaching where he prioritized student learning. He believed that the teachers should make students generate alternative ways and make them ready for life; however, he did not claim any contribution from the students in this process.

P5's school context was supportive. Although his students lacked considerable knowledge and skills in mathematics due to the frequent teacher change (recall that P5 was the 15th mathematics teacher within one year), P5 did not feel discouraged.

In summary, P5's teaching beliefs did not change from 2003 to 2004 and he believed that teaching was an authoritarian practice where students had no contribution to the ongoing classroom activities. P5's long TPC teaching experience might have a considerable influence on his teacher-centered beliefs. Since TPC teaching did not include any student-centered teaching practices (but focused on question solving skills in an examination setting), he came to believe that students learned with teacher-centered approaches. As a result, he maintained these beliefs even after he started to teach in a public school.

Beliefs about Learning Mathematics

P5's learning beliefs also did not change from 2003 to 2004 and maintained at Level 0. He believed that students' correct responses for the examination questions showed that they learned the concepts. He articulated more on his beliefs in 2004 and claimed more details:

> *"You process something and give it to the kid, and he scans this, imitates this, and evaluates in his environment and tells 'here is the result.' You see it in the examination paper" (P5, 2004, Q18).*

P5's 2004 beliefs indicated that he maintained his previous Level 0 beliefs and revealed more. Learning was a teacher initiated process for P5 where students imitated the procedures. His beliefs about the role of skills were also consistent with his above expressions. He believed that students' only responsibility was to scan the topic of the day like reading a novel before coming to the class. He believed that *"locating [mathematical knowledge]" in his mind and making him do his homework" (P5, 2004, Q3)* was a teacher's responsibility, indicating Level 0 beliefs.

In summary, P5's 2003 Level 0 learning beliefs were maintained and became more central in 2004, where he believed the authoritarian teacher-centered approach would result in student learning and that students were not a part of the learning process.

Other Changes and Conclusions

The major and minor changes in P5's mathematics related beliefs seemed to be a result of the change in his teaching context. P5's beliefs about the types of knowledge necessary for teaching mathematics reflected this change as well.

In 2003, P5 believed that a mathematics teacher should have content knowledge and knowledge of daily life connections to teach mathematics. When he started to teach at a rural public school after a considerable period of TPC teaching (about 3.5 years), he seemed to develop nurturing beliefs in 2004 related to teaching, such as being a model for the students. This also might be due to his additional duty at the school as the school counselor.

The unchanged nature of P5's Level 0 teaching and learning beliefs could be attributable to teaching at a TPC for a long time. The ways mathematical knowledge, teaching and learning mathematics were considered in the EME program were quite different than the ways they were considered at TPCs. It seemed that P5's 2003 teaching and learning beliefs were shaped by his practice at the TPC rather than his studies in the EME program. Although P5 claimed that his ideas related to teaching changed after he started to teach in the public school, he only changed the way he addressed mathematical knowledge in teaching.

In summary, P5's long TPC teaching experience provided the context for maintaining and centralizing his Level 0 teaching and learning beliefs. However, teaching in a totally different context evoked certain Level 1 beliefs about the nature of mathematics.

Mixed-Change Group

The final group of participants to consider was the mixed change group. P4, P6, P10, and P11 had mixed increase and decrease in their belief levels in different areas from 2003 to 2004. Among them, P4, P10, and P11 had the same pattern of change in their belief levels, while P6 had completely a different pattern of change. P4, P10, and P11's belief levels in the nature of mathematics decreased from Level 1 to Level 0 after the first-year of teaching, while their teaching belief levels remained at Level 1 and their learning belief levels increased from Level 0 to Level 1. In contrast, P6's belief level in nature of mathematics increased from Level 1 to Level 2, his teaching belief level decreased from Level 2 to Level 1, and his learning belief level remained at Level 2 after his first-year of teaching. Since the participants in this group except P6 had the same pattern of change, the analysis of their beliefs will be reported together and P6's analysis will be reported separately. Table 6.6 shows gender and belief levels of participants and their teaching contexts.

Table 6.6

Gender, Teaching Context, Belief Levels of Participants Who Had Mixed Changes in their Belief Levels.

	Gender	Teaching Context	N2003	N2004	T2003	T2004	L2003	L2004
P4	F	Public	1	0	1	1	0	1
P10	F	Public	1	0	1	1	0	1
P11	F	Public	1	0	1	1	0	1
P6	M	Public	1	2	2	1	2	2

P4, P10, and P11. The mixed-change participants P4, P10, and P11 were teaching in rural public schools at the time of the 2004 study. The participants had a different range of teaching experiences during their college education in the EME program and had generally similar experiences in their first year of teaching.

P4 had student-club teaching, TPC teaching, and private tutoring experiences for one year before graduating from the program. In her first year, she worked at a TPC for a semester, and then started to teach middle school mathematics and science as well as high school mathematics at a rural public school.

P10 had private tutoring experience for one year during college, along with a short TPC experience. After teaching at a TPC for a semester in her first year, she started to teach at a rural public school as the 5th teacher assigned to teach middle school mathematics in that school in the 2003 – 2004 academic year.

Unlike P4 and P10, P11 did not have any informal teaching experiences during her studies in the EME program[12]. In her first year, she taught middle school mathematics at a rural public school. Additionally, she was teaching to prepare students for the national examination during the weekends at a school-supported TPC[13].

P6. P6 was one of the participants who had considerable teaching experience during his college education. He taught mathematics in the student-club teaching project for three years and in an orphanage for four years. He taught middle school mathematics at a public school in his first year. In his teaching context, he voluntarily conducted problem-solving sessions for his students either after class or during weekends. In the problem-solving sessions, he generally assigned a single difficult problem which students often could not solve completely, and he discussed it with them in detail. His college and first-year teaching experiences could be considered distinct among all other participants in the study.

Beliefs about Nature of Mathematics

P4, P10, and P11. The mixed-change participants mainly believed in 2003 that mathematical knowledge included logical relationships between the ideas. They believed that mathematics could be seen as a phenomena integrated into daily life, not apart from it. For example, P4 claimed that mathematical thinking was the tool that one could use in *"comparing things [and] evaluating situations" (P4, 2003, Q1)*. However, in 2004, mathematics was not considered as a mental tool by the participants, but as a helper for

[12] Recall that all participants had three semesters of student teaching in the EME program. The other teaching experiences (such as TPC private tutoring, and student club teaching) were not organized by the EME program but were arranged by participants.
[13] In rural areas where there is no TPC, schools provide students with weekend courses where the school teachers teach in order to prepare students for the national exams. School supported test preparation courses are organized by the school administrators.

basic everyday calculation, as P4 illustrated: *"[Mathematics is in] [a]t least when we go to a supermarket... We learned [math] slowly since it is in everything" (P4, 2004, Q3).* They believed that building mathematical knowledge was simply reaching correct answers of given questions, which was a Level 0 belief.

P4, P10, and P11 did not say much about the nature of mathematical problems in 2003. Their expressions indicated Level 1 beliefs where a mathematical problem was a question or a situation expressed in a narrative form. They claimed that mathematical problems needed advanced thinking skills to be solved. Somewhat interestingly, although participants' belief levels about the nature of mathematics decreased from Level 1 to Level 0 in 2004, their Level 1 beliefs about the nature of mathematical problems in 2003 became more detailed in 2004. Participants realized in 2004 that *"the thing that [was] expressed in long sentences was not actually a problem, but a normal operation question" (P4, 2004, Q8)*. Moreover, for the participants, a mathematical problem should be the situation that *"[one] should not see the solution initially" (P11, 2004, Q8).*

The participants in the mixed-change group had different beliefs about indicators of rich mathematical understanding in 2004, such as asking questions, verbalizing one's own understanding, and solving questions that no one in the class could solve. Their beliefs about rich mathematical understanding indicated a belief level between Level 0 and Level 1.

Mixed-change participants had different beliefs about the usefulness of mathematics courses in the EME program, but their beliefs were consistent from 2003 to 2004. P4 consistently believed that mathematics courses provided her with connections between mathematics concepts, although she realized this contribution later in her education. P10 and P11 believed that the courses were useful in terms of increasing their mathematical content knowledge but had no effect on teaching middle school mathematics.

In summary, mixed-change participants P4, P10, and P11 generally had similar beliefs on subcategories concerning nature of mathematics except on the indicators of rich mathematical understanding. Only P4 believed that the content courses were useful in teaching mathematics. Although participants' 2004 beliefs about the nature of mathematics were generally at a lower level, their beliefs about the nature of a mathematical problem were at Level 1. This simultaneous existence of Level 0 and Level 1 beliefs in 2004 might be due to the centrality of their 2003 beliefs. Although participants' 2003 beliefs were not fully maintained at Level 1 until 2004, their beliefs were somewhat less peripheral so that participants still had Level 1 beliefs in some of the subcategories in 2004.

P6. P6 was the only participant whose beliefs about nature of mathematics increased from Level 1 to Level 2 from 2003 to 2004. His Level 2 beliefs were consistent through all sub-areas in the nature of mathematics in 2004. He claimed several times in 2003 interview that *"the fundamental of mathematics [was] logical thinking" (P6, 2003, Q1).* He believed in 2004 that *"a person who comprehend[ed] mathematics [could] always interpret [logically]. He [could] build the cause-effect relationship in the discussions" (P6, 2004, Q2).* Not only were his beliefs more detailed in 2004, but also they were at a higher level (Level 2) compared to 2003 beliefs (Level 1).

The level of P6's beliefs about nature of mathematical problems was also at a higher level in 2004. P6 believed in both 2003 and 2004 that a mathematical problem should have a daily life connection. He considered mathematical problems as *"the questions that [took] their fundamentals from the daily life, that [could] be expressed through mathematical symbols, and that [could] be solved and interpreted in daily life" (P4, 2003, Q7).* He believed in 2004 that *"[a mathematical problem] could not be answered by routine (not thoughtful) answers" (P6, 2004, Q8).* He distinguished a mathematical problem from a routine question by emphasizing its connection to daily life and the thinking skills that should be used to solve it.

P6 had Level 2 beliefs about the indicators of rich mathematical understanding in 2004 as well. He believed that a student with a rich level of mathematical understanding should be able to carry out the solution of a mathematical problem and should be able to ask for reasons underlying mathematical procedures.

P6 believed in 2003 and 2004 that the mathematical content courses in the EME program improved his mathematical thinking skills. He consistently claimed that the content courses provided him with the skills of questioning and understanding the fundamentals of mathematics. He believed that he reflected his own thinking skills on his teaching by emphasizing proofs of many principles in the classroom:

> *"I try to address the proofs more or less, I don't want it to be [an] empty [can]. I don't want them to ask "Where these things come from?" I want them to have the skill [to prove the principles]" (P6, 2004, Q31).*

P6 had Level 2 beliefs about the nature of mathematics, mathematical problems, characterization of rich mathematical understanding, and how he reflected his own mathematical thinking to the students. His beliefs were built on his central belief that mathematical knowledge was a web of logical relationships, which he consistently stated in both 2003 and 2004 interviews.

Beliefs about Teaching Mathematics

P4, P10, and P11. The mixed-change participants P4, P10, and P11 maintained the level of their 2003 beliefs (Level 1) about teaching mathematics in 2004. Participants believed in 2003 that mathematics teaching should be in a teacher-centered classroom environment, where the teacher *"should know different methods, implement these methods in the class, and should know how to evaluate the results in a better way" (P4, 2003, Q12).* Mixed-change participants had similar beliefs in 2004 and they also believed that the teacher should *"behave in a way that would make students want to learn more" (P4, 2004, Q19).* Although they believed that the teacher-centered classroom practice would be effective in teaching mathematics, this practice should include different methods of teaching mathematics and ways of motivating students. Participants did not clearly mention the teaching methods they would use, but these methods could be considered as teacher-centered versions of mathematics teaching methods they have studied in two methods courses, such as discovery learning and problem solving. Their aims in teaching mathematics also indicated consistent Level 1 beliefs in both 2003 and 2004. They generally believed that it was the teacher's responsibility to make the students enjoy mathematics or to prepare them for further steps of education by sharing their knowledge. However, they did not mention any role that students might have during this process.

P4, P10, and P11 had similar first-year teaching experiences, especially when their final teaching contexts (rural public schools) were considered. Having students without essential prerequisite knowledge and future educational goals was a limiting factor for participants' teaching. Moreover, the curriculum was loaded for the participants especially because they were expected to keep the same pace with the yearly plan despite being assigned to their schools in the middle of the academic year. These limitations might be a factor in maintaining teacher-centered Level 1 beliefs since the participants were able to deal with these factors only through teacher-centered practices.

In summary, mixed-change participants mainly believed that a teacher should implement different teaching methods of mathematics in a teacher-centered classroom and should make students enjoy mathematics. Although there were limiting factors in their school contexts (such as keeping the same pace with the curriculum where the students were lacking essential knowledge), they were able to maintain their belief levels at Level 1 from 2003 to 2004.

P6. P6's Level 2 beliefs about teaching mathematics in 2003 decreased to Level 1 in 2004. He believed in 2003 that mathematics teaching should be organized in the way that students would *"implement, think, interpret, and product results" (P6, 2003, Q13)* by the help of instructional materials and activities. Being driven by these Level 2 beliefs, P6 built a mathematics laboratory in his school in the beginning of his first year where his administrator provided all of the resources that he asked for. However, after the first-year teaching (in 2004), he believed that mathematics laboratory should serve to improve students' attitude and motivation instead of helping them to construct knowledge:

> *"It is sometimes a magic for the kids, sometimes something that they haven't seen before. You make kids both like mathematics and respect you" (P6, 2004, Q3).*

His 2004 aim was also at a lower level in that he claimed himself as the main responsible person who would develop mathematical behaviors in students' minds. Although he placed the teacher at the center of teaching, his placement was not the same as that of other mixed-change participants (P4, P10, and P11). The extra problem solving hours that P6 organized voluntarily in his school showed that he prioritized increasing students' mathematical thinking skills by guiding them in their thinking while they were solving problems. However, limiting factors, such as the curriculum load, seemed to affect his teaching in the mathematics classroom (during the school hours) and lowered his belief level. When P6's teaching practice in the problem solving hours was considered, his overall Level 1 teaching beliefs might be addressed as less teacher-centered than the other mixed-change participants' (P4, P10, and P11) beliefs.

Beliefs about Learning Mathematics

P4, P10, and P11. The mixed-change participants P4, P10, and P11 had Level 0 beliefs about learning mathematics in 2003 and Level 1 beliefs in 2004. They believed in 2003 that solving many questions correctly was the indication of learning mathematics. Moreover, they did not mention any responsibility that students should take for their own learning during the 2003 interview. Their beliefs in 2004 indicated that the students should spend some effort other than solving questions correctly so that they could learn mathematics:

> *"[Mathematics] cannot be memorized, or it cannot be taken as a prepared software. You have to reach mathematics" (P10, 2004, Q3).*
>
> *"When we talk about learning, there comes… comprehending… You should know the rules, why you do what you do, generalization… and if*

you are learning generalization, then you will be able to implement it to specific cases" (P11, 2004, Q3).

In addition to the Level 1 learning beliefs stated above, participants believed that having a positive attitude towards mathematics was an important catalyst in learning mathematics. Although mixed-change participants generally had Level 0 beliefs in 2003, they believed that students could learn and think about the mathematical concepts in different ways. They maintained these beliefs in 2004 as well.

In summary, mixed-change participants' 2003 Level 0 beliefs that reduced learning to merely solving questions correctly changed in 2004. They believed in 2004 that students should spend effort in comprehending, generalizing, and implementing so that they would learn mathematics. Having a positive attitude towards mathematics was an important factor in this process.

P6. P6's Level 2 beliefs about learning mathematics in 2003 were maintained and became more detailed in 2004. Initially, he believed that mathematics could be learned through *"interpreting, understanding, [and] thinking" (P6, 2003, Q12a).* His latter beliefs indicated that students should learn mathematics *"through experiencing it [and] by observing what it works for" (P6, 2004, Q3).* Moreover, since students would know where they could use mathematics by the help of various instructional materials, *"[they could] learn mathematics as a behavior" (P6, 2004, Q3).* Although some other inservice participants of the study had beliefs about learning mathematics through understanding the use of mathematical knowledge, they never mentioned converting these experiences into actions that could be observable, as P6 did.

P6 claimed in 2004 that having students with different levels of knowledge and skills was not unexpected for him. Although he had students who lacked prerequisite knowledge, he still believed that they could learn mathematics by experiencing it through the instructional materials. In summary, P6's Level 2 beliefs were more detailed in 2004 in which he characterized learning mathematics as a collection of advanced thinking skills that could be converted into actions that students could practice.

Other Changes and Conclusions

P4, P10, and P11. The mixed-change participants' (P4, P10, and P11) beliefs about the type of knowledge and skills that a mathematics teacher should have and their perceived needs in the EME program seemed to provide evidence for the effect of their teaching context on their mathematics related beliefs. P4, P10, and P11 generally believed in 2003 that a mathematics teacher should have mathematical and pedagogical content knowledge (PCK) in order to teach mathematics effectively. Somewhat interestingly, having skills that would increase student enjoyment in mathematics was more important than having content and pedagogical content knowledge in 2004. Participants' beliefs that prioritized increasing students' attitudes towards mathematics seemed to be related to their experiences in their teaching contexts. Since participants had parents and students who typically did not have further educational goals, they had to deal with students lacking both the essential knowledge of and the interest in mathematics. Hence, their learning beliefs, aims for teaching mathematics, and beliefs about the skills essential for teaching mathematics prioritized increasing student attitude towards mathematics.

Similarly, mixed-change participants' perceived needs in the program in 2004 were affected by their beliefs that prioritized increasing student attitude. Participants believed that there should be more PCK courses and pedagogical knowledge courses in the EME program. Having more pedagogical knowledge on middle school students was important for the participants probably because they believed that these courses would provide them a knowledge base for increasing student interest in mathematics.

Although P4, P10, and P11 had different teaching experiences while in college, their nature, teaching, and learning beliefs were at the same level when they graduated from the EME program. This might suggest that participants' preservice teaching experiences, such as TPC teaching or private tutoring, did not strongly affect their belief levels. The mixed-change participants P4, P10, and P11 taught in rural public schools in their first year and they had similar changes in their belief levels. Having the same changes in belief levels in 2004 might indicate that the similar rural public school context affected participants' belief levels in similar ways.

Teaching in rural public schools was not easy for the participants when their school contexts were considered. Students' level of knowledge and skills were lower than what it should be. This was mostly caused by continuous teacher change in participants' teaching contexts. The participants claimed that their schools did not have mathematics teachers who taught in the school for more than a semester. Moreover, previous teachers who were not certified as mathematics teachers had to teach mathematics in participants' schools since there was no mathematics teacher. Hence, participants' students typically did not have sufficient mathematical knowledge. Moreover, the continuous change of

[14] Recall that the principals generally have the authority to assign teachers to various content areas even if they are not certified to teach the content.

mathematics teachers that occurred prior to the participants' arrival made it very difficult to analyze what students knew or did not know. Somewhat interestingly, participants' teaching belief levels remained the same at Level 1 in these contexts, whereas the level of their beliefs about the nature of mathematics decreased to Level 0 and the level of their learning beliefs increased to Level 1.

P6. P6's beliefs about the types of knowledge and skills that a mathematics teacher should have were different than all other participants of the study, especially in 2004. Although he prioritized being competent in PCK over having a positive attitude towards teaching in 2003, his ranking was reversed in 2004. P6's strong desire to be a teacher since high school possibly influenced his beliefs about the knowledge and skills of an effective teacher. He considered having a positive attitude towards teaching as the most important qualification of a teacher. Somewhat interestingly, despite the increase in his belief level about the nature of mathematics, he ranked content knowledge as the last type of knowledge needed for teaching in both 2003 and 2004. On the other hand, this did not mean that he thought content knowledge was unimportant. He claimed that he had been trying to improve his content knowledge by reading mathematical journals since the beginning of his studies at the EME program.

In relation to P6's characterization of the knowledge types and generally higher level of mathematics related beliefs, he did not claim any need for the PCK or the content courses in the EME program. He indicated that a course on the educational system and policies in Turkey and more courses on the psychology, sociology, and philosophy of education should be added to the EME program in both 2003 and 2004.

In summary, P6's strong beliefs about teaching mathematics in 2003 possibly helped him to create opportunities for himself and his students, such as building a mathematics laboratory and organizing extra problem solving hours during his first-year teaching. These opportunities probably resulted in an increased belief level concerning the nature of mathematics (from Level 1 to Level 2) and a maintained belief level in learning mathematics (Level 2). The responsibilities that the classroom teaching environment brought, such as the curriculum load and the knowledge level of his students, influenced the level of his teaching beliefs in a negative way, although these factors were not unexpected for him. He claimed he always believed that mathematics should be reachable and enjoyable for everybody and this could be possible through developing students' mathematical behaviors. However, his 2004 teaching beliefs did not support this claim. P6's 2003 Level 2 teaching beliefs were probably less central. When he was challenged by the real-classroom environment, he revealed Level 1 beliefs.

Summary

Presenting five groups of change patterns for a total of 12 inservice participants was an important process in terms of detecting the common experiences and factors that impacted the beliefs and change in beliefs and how these common experiences shaped inservice participants' beliefs. The results documented that inservice participants had many common pre-college and preservice experiences and contextual factors or conditions in their first-year teaching. When the impact of these common experiences was investigated, it became apparent that common experiences as a student and as a teacher influenced individual inservice participants in different ways. As a result of impact differences, there were little overall commonalities in inservice participants' beliefs and belief change patterns. The nature of these common experiences and factors will be presented here in relation to the differences in belief change patterns.

There were common pre-college, preservice training, and first-year experiences for all inservice participants. All inservice participants studied the same national curriculum during their high school education and took the same university entrance examination. While in the EME program, they took the courses in a single section and they were all teaching the national curriculum in mostly similar grade levels. Moreover, almost all inservice participants had some informal teaching experiences during their preservice training. They were teaching in the national curriculum context mostly in rural schools to students with diverse knowledge levels in the same classroom.

Given the common nature of their preservice and first-year experiences, it might be expected that inservice participants would have similar belief change patterns after the first-year of teaching. However, the results showed that belief change was not a linear result of single or few factors impacting in similar ways, even when major factors in inservice participants' preservice and first-year contexts were common. Instead, each participant's belief change was a result of a unique combination of different interacting experiences impacting in complicated ways. For example, the slight-increase participant P5 had considerable TPC teaching and private tutoring experiences during his EME program studies, which resulted in low level of beliefs in 2003 and a very slight increase in 2004. In contrast, P6, who taught in the student club project for a long time while studying the EME program, developed the highest level of beliefs among the inservice participants in both 2003 and 2004. Although both P5 and P6's informal teaching experiences could be considered as experiences in classroom contexts and in university entrance examination preparation, they had very different beliefs and belief change patterns. The ways P5 and P6 considered these informal classroom teaching experiences as effective in students' learning seemed to impact the ways they processed the program experiences and developed new beliefs. While P5 believed that students could learn mathematics in the teacher-centered way he was practicing at TPC, P6 did not consider examination preparation teaching as an effective way of learning and mostly had student-centered beliefs. Therefore, despite the very common nature of their informal teaching experiences (in addition to the common EME program experiences), P5 and P6 had different levels of beliefs in belief areas in both 2003 and 2004, depending on the way they considered these experiences in relation to other experiences they had.

Results showed that commonalities in major factors and background did not imply similar beliefs or belief change patterns, as exemplified above. Although there were common major factors impacting the belief change, some other minor factors, such as the number of students and different grade levels taught during the first year, had a considerable influence. For example, while P8 and P9 were teaching in rural schools to similar range of grade levels, P8 was in consistent-increase group while P9 was in slight-decrease group. Similarly, P6 and P12 were teaching two grade levels where public school teacher P6's student population was three times the population of P12's students who was working in a private school. Although P12 might be expected to have higher level beliefs or an increase pattern due to his less loaded work and easier access to resources compared to P6, he was placed in slight decrease group with relatively low level of beliefs where P6 mostly maintained his high level of beliefs at the end of the first-year teaching.

In some cases, participants in the same change pattern group had different sets of experiences. A general look into the pattern group results showed that participants in the no-change and consistent-increase groups had different preservice and first-year teaching experiences but similar change patterns of mathematics related beliefs. Similarly, participants in mixed change group (except P6) had some differences in their preservice and informal teaching experiences, but teaching in similar rural contexts in their first year resulted in similar belief change pattern.

One reason for presenting inservice participants' beliefs in different change pattern groups was to document the interaction of several factors that resulted in the non-linear cause-effect relationship. As could be seen in the above emphases, focusing on a single factor did not provide a complete and accurate explanation for each belief change pattern. The detailed change descriptions for small number of participants in each change pattern group demonstrated how major and minor factors interacted in unique ways for each participant. This detailed picture of several unique change processes helped in understanding, exploring, and generalizing, as well as to identify the impact of major factors (to be documented in the next chapter).

In addition, this analysis confirmed the impact of certain other factors on participants' mathematics related beliefs such as the impact of pre-college education. Although EME program courses presented a common context and set of experiences, almost none of the courses were designed to challenge or make them reflect on their beliefs, which is a feature of interventions that has proved to have an impact on preservice teachers' beliefs (Gill, et al., 2004). Moreover, research indicates that preservice teachers tend to maintain their pre-college mathematics related beliefs though their teacher education program experiences (Cooney, 1999). Thus, it could be speculated that inservice participants filtered these experiences by their unique set of pre-college beliefs and experiences, probably interacting with other factors. The diversity of participants' beliefs about the usefulness of the program courses and experiences when they graduated from the program highlighted that EME program experiences were filtered by pre-college and informal teaching experiences and beliefs in different ways for each participant.

In summary, the change patterns in inservice participants' mathematics related beliefs from 2003 to 2004 showed that there was no single factor or a single experience resulting in belief change. Each participant had a unique personal history composed of several different sets of unique experiences gained during pre-college education, preservice training, and first-year of teaching. Personal histories impacted participants' mathematics related beliefs in different ways and resulted in different patterns of belief change. In other words, inservice participants' beliefs and changes in beliefs had very few common features despite the commonality of major factors in their background and teaching contexts. The commonalities detected among the factors and resulting belief changes will be focused in the following chapter.

CHAPTER 7

FACTORS AFFECTING INSERVICE PARTICIPANTS' BELIEFS

In the previous chapter, the data indicated that inservice participants mostly believed in the effectiveness of teacher-centered practices for teaching and learning in the mathematics classroom. Teacher-centered beliefs were consistently stated in participants' 2003 and 2004 interviews. Participants often emphasized the use of different teaching methods such as discovery and they considered students' interest in learning mathematics as important. However, they tried to address these concerns by teacher-centered practices in the mathematics classroom. When the inservice participants elaborated on the use of different methods of teaching mathematics and students' role in learning, they referred to certain experiences in the EME program and in the first-year of teaching.

The experiences that might have an impact on inservice participants' teacher-centered beliefs will be analyzed in detail in this chapter. These experiences were reported by the inservice participants as the courses and experiences during their studies in the EME program, curriculum pace, and contextual and systemic factors within their teaching context such as students' knowledge level and being impacted by the Ministry. These experiences often seemed to have a combined influence on participants' beliefs. Participants seemed to re-interpret their experiences and beliefs gained in the EME program through their first-year teaching experience. At the end of their first year, participants seemed to transform their beliefs into more teacher-centered beliefs in which they considered using different teaching approaches and some roles for the students. This chapter will explore the transformation in participants' beliefs and document the factors that had a considerable impact on them.

Different Teaching Methods in the Teacher-Centered Classrooms

Inservice participants took several courses on methods of mathematics teaching in the EME program until they graduated in 2003. These courses emphasized more student-centered teaching methods such as cooperative learning and discovery in teaching mathematics and also teaching middle school concepts by using them (see ELE 336 and ELE 443 course outlines in Appendix B). Participants explored teaching mathematics through the use of different pedagogical approaches in the methods courses where student-centered practices were emphasized, prepared lesson plans for teaching middle school mathematical concepts by implementing these approaches, and presented these lesson plans to their friends and the professor pretending they were in a middle school classroom. Such methods courses seemed to have an impact on participants' beliefs about mathematics teaching in 2003 when they graduated from the program, as they expressed:

> *"Actually, I learned a lot of things [in the methods courses]. I did not know teaching would be [conducted] in this way before. Moreover, I did not know teaching mathematics would be [conducted] in this way. My views changed a lot" (P4, 2003, Q22).*
>
> *"My views changed directly. I was not aware of [the state of teaching mathematics] before. Actually, I have so much confidence now" (P10, 2003, Q22).*

Similarly, the mathematics education professor, Dr. C., claimed that he observed a "change" in the program students after they started taking PCK courses. Among these courses, Dr. C. claimed that the elective course "Activity-Based Mathematics Instruction" that he offered only to the 2003 graduates (to inservice participants) was the most important one in terms of affecting participants' beliefs. He specifically targeted preservice teachers' beliefs about mathematics teaching in schools in that course: *"I was trying to emphasize that the mathematics teaching when they were students [in the pre-college education] and the mathematics teaching they would practice should be different" (Dr. C., 2004, Q11)*. His efforts seemed to impact participants' way of considering the mathematics teaching, as most participants particularly addressed the course as eye-opening: *"There was a course that made me go towards completely a different direction, that changed me, which was the Activity-Based Mathematics Instruction [...] That [course] changed my view. It was something that I have never come across" (P3, 2003, Q23)*.

Pedagogical content knowledge courses in the EME program had some impact on the way the inservice participants considered mathematics education in the classroom, as indicated by their reference to the courses and different mathematics teaching approaches. However, the courses and the EME program in general seemed to lack real-classroom practices. The professor stated that there was a need for practice of the knowledge and skills learned in the PCK courses, *"in order to be integrated into [program students'] personality as a teacher" (Dr. C., 2004, Q10)*. He claimed that since the program lacked sufficient opportunities for practice, the program students could not implement these knowledge and skills and see how and what they worked for. Most participants were aware of the lack of practice in the program when they graduated, as P1 illustrated: *"I would like to experience the implementation of methods course in the* *classrooms. [It's] because you don't practice it, you just see it in theory [...] Practice courses (School Experience and Practice Teaching courses) do not provide [practice of methods of teaching] that much" (P1, 2003, Q22).* After the first year of teaching, almost all participants claimed that since the program lacked sufficient opportunities for practice, they had difficulties while teaching in real-classroom settings.

The difficulties inservice participants had in their first-year were mostly related to the lack of experience in classroom management and in implementing different teaching methods and materials in the classroom. When participants were faced with various components and tensions of the classroom, such as managing the students and the time simultaneously, they mostly had difficulty in teaching mathematics through student-centered ways. P1 explained this problem after his first year of teaching by referring to the nature of the methods courses where participants practiced teaching a concept through a specific method in the regular course hours to their classmates:

> *"[I don't know] how students would construct mathematical concepts in practice... but in practice.... I know it [in the program courses], I teach it in the practice course, [and] I teach it assuming these university students were middle school students [...] I don't really know how [teaching] a mathematical concept is practiced in any school in any classroom" (P1, 2004, Q25).*

For the inservice participants, the way the course content was practiced in the EME program was far removed from the conditions of the real-classroom settings. However, most inservice participants were not aware of the extent of this difference until they started the first-year teaching: "*We learn [in the EME courses] really ideal things [for* *teaching mathematics], we implement these ideal things [during the courses], [and] I think I now have the disappointment [because] of those [ideal] experiences" (P10, Q31, 2004).* Given that the participants lacked more realistic teaching experiences during the EME program, it was difficult for them to implement student-centered methods in the mathematics classroom although they believed in the effectiveness of these methods in teaching mathematics. Classroom contexts and curricular concerns were limiting factors for the participants.

Considering the limitations in real-classroom contexts, participants were inclined towards believing in the effectiveness of teacher-centered practices in which some student-centered approaches were integrated in the most time-efficient way. These beliefs and associated practices seemed to work better in the real-classroom contexts for the inservice participants. For example, P3 described several practices in which she conducted teacher-centered version of a student-centered teaching approach, considering the student differences in her class:

> *"[...] considering the [students at the] lowest level [of knowledge] and not really [organizing] everything for them but [explaining mathematical concepts] in a way that they would catch up works [in the classroom] [...] When they measure the perimeter of a circular region and divide it by its diameter and when I ask for few students to write their results on the board to compare, students believe that they discovered the Pi number" (P3, Q16, 2004).*
>
> *"Sometimes I try to make them discover things by worksheets. For instance, they count the number of [small] squares in a [large] square to*

find the area of the square, then they do count the [small squares] in a rectangle" (P3, Q16, 2004).

In the above practices and similar ones that the inservice participants described, the common issues were using a worksheet on which students would discover principles or characteristics of mathematical concepts either as a group or individually, mostly by using everyday manipulatives such as ropes. The teacher was the main decision maker and explained most of the tasks to the students in the classroom. Students were using the manipulatives, measuring, and calculating in order to "discover" the nature of the mathematical concepts and responding to the teacher's questions. Similar practices were presented in courses related to the methods of mathematics teaching in the EME program. Participants generally claimed that they referred to their portfolios or course materials from time to time while planning learning activities for the students.

It seemed that preservice participants developed beliefs about the effectiveness of student-centered methods of teaching mathematics through the methods courses in the EME program. However, they could only implement the surface features of these methods in which students discover few mathematical ideas in a very teacher directed way. Although they benefited from the EME program course materials in planning these short periods of student-centered practices, the main features of these practices in which students had more responsibilities were not implemented. Participants' lack of experiences in practicing student-centered teaching approaches seemed to be a limiting factor in implementing these approaches in the real-classroom contexts.

The participants had generally more informal teaching experiences in private tutoring and Test Preparation Center (TPC) settings, as compared to their real-classroom experiences in the EME program. The informal teaching experiences were teacher-centered and were focused on getting the correct answer since most of the informal teaching settings were examination-preparation oriented. Thus for the participants, private tutoring and TPC experiences were not helpful in thinking about the concerns of the real-classroom settings, such as gaining student attention. Therefore, participants often had to re-evaluate their teaching beliefs and practices gained during the informal teaching experiences when they were in real-classrooms settings, as they expressed below:

> *"[Already] prepared students come to the TPCs and you only teach them certain things. You don't have to gain attention, you don't have to make them enjoy [the class]. They already come [to the TPC] with a goal in mind, [and] they learn. However, this is not [the case] in public school teaching" (P4, 2004, Q24).*
>
> *"Teaching in a classroom is so much different. In private tutoring, you can [open] a book if you feel like you don't really know [the concept]. You don't need to make [the student] like mathematics, give [him/her] daily life examples. You are [just] required to make [the student] solve as many questions as [he/she] can" (P10, 2004, Q25).*

Inservice participants' private tutoring and TPC teaching experiences seemed to limit the way they considered mathematics teaching. They realized this limitation when they started to teach in school contexts in their first year. This awareness seemed to help them re-organize their practice by integrating different methods of teaching mathematics such as using manipulatives and discovery. Even though participants considered more student-centered approaches in their teaching, students' role was still very limited in discovering mathematical ideas and teacher was still directing all classroom activities.

In summary, EME program courses seemed to have some impact on inservice participants' beliefs about teaching mathematics, as they used some of their knowledge from these courses in their teaching. However, this impact was limited due to insufficient practice opportunities in the EME program and participants' teacher-centered informal teaching experiences during the preservice education. Participants were underprepared in the EME program to practice student-centered methods in the real-classroom contexts. Hence, they mostly referred to their informal teaching experiences which were generally longer than their real-classroom teaching experiences. These factors influenced their way of addressing student-centered teaching in the mathematics classroom towards a hybrid of teacher-centered practices including some student-centered moments.

Real-classroom contexts include several factors impacting teachers' practices in complicated ways. When inservice participants started to teach in real-classroom settings, they had to deal with other contextual and systemic factors that directed them towards teacher-centered beliefs and practices in which student role in learning was limited. These factors and related concerns about the students are explained below.

Concerns about Students in the Teacher-Centered Classroom

Inservice participants' experiences with students as beginning teachers in real-classroom contexts seemed to be unexpected for them. Certain responsibilities and pressures appeared to have considerable influence on participants' beliefs about the effective ways of mathematics teaching. The responsibilities and the pressures were related to the tension between the curriculum pace controlled by the Ministry of National Education (MNE) and participants' concerns about student learning.

Most of the inservice participants had classrooms where students had poor and unequal mathematical knowledge and skills. The participants observed that only a small number of their students had sufficient knowledge and skills upon which new mathematical knowledge could be built. However, the inservice participants did not have the time to complete students' missing previous knowledge and skills because they had to be in the same pace with the yearly plan based on the national curriculum, as P12 explained:

> *"[Let's say] I taught the 3rd unit and passed to the 4th one. But I know that there are many [students] who could not comprehend many [concepts] in the 3rd unit [...] I can see this! [...] [Sometimes the students] say that they did not understand it fully. But since there is a curriculum that I have to keep a pace with, I skip [re-teaching] [...] While teaching the 4th unit after the 3rd one, there are things in the 4th unit [related to] the 3rd one. This time, I cannot really [teach] the 4th unit. There is always this disconnectedness [and] it is going like a chain" (P12, 2004, Q23).*

Moreover, many participants who were teaching in rather rural contexts were assigned to their schools several months after the school year started. Yet, they were expected to cover the previous concepts in that years' plan and keep up with the curriculum pace that required them to teach a specific concept at a specific week. Most participants claimed that it was difficult to cover everything stated in the curriculum at the specific time period defined for each concept in the yearly plan, as P11 illustrated: *"If it would be left to [my* *decision], I would teach the fractions for a month [...] [You must] compress [the concepts, in order to keep the pace] (P11, 2004. Q22).* Moreover, the consistency between the participants' pace in teaching and the pace of the yearly plan was inspected by the MNE which brought additional pressure for the participants:

> *"I mean, you don't have to teach something to a kid. The fact that [the concept in the yearly plan] had been completed is sufficient for the curriculum [pace], I mean the person who inspects [the pace of the teacher] would like to see that. He would take look at the [plan] book and would conclude that the teacher taught this on this day. I think this is wrong" (P5, 2004, Q22).*

The lesson plans that the participants wrote for the concepts identified for each week in the yearly plan were also investigated by the MNE officers both for structure and implementation. However, for the participants, implementing a lesson plan did not really show that the concept was learned by the students:

> *"The inspector is not interested in whether you taught sufficiently or not, or you started to teach [in that school] later [in the semester]. He expects you to write directly whether you are in the same pace with the yearly plan or not. I mean [...] this would not be realistic since I have not been teaching in that class since the beginning of the year" (P10, 2004, Q22).*

In addition to the pressure that the curriculum pace put on participants' teaching, the lack of consideration of student differences in the curriculum brought extra difficulty for the inservice participants. When participants started to teach in the heterogeneous classrooms, it appeared that they were also not prepared to do so. Many participants expressed difficulties associated with teaching to a group of students having mixed levels of knowledge under the same curriculum. It seemed that heterogeneous classrooms were somewhat unexpected and disappointing for the participants, as P3 explained:

> *"There are things that I am disappointed with. But I was able to find 4-5 kids that I was in the same frequency [...] you teach a class, it's crowded, but the kid in the front seat asks a question, [he/she] asks something different. I immediately answer only that question. Others don't even hear it, I mean they don't even see (realize)" (P3, 2004, Q13).*

Participants' disappointments and difficulties expressed above and in the previous chapter suggested that they did not have sufficient experience with heterogeneous classrooms during their studies at the EME program. It seemed that they mostly considered homogeneity in the classrooms in terms of student knowledge and skills. When the participants experienced difficulty in dealing with the students and the curriculum pace at the same time, they seemed to incline towards teacher-centered beliefs since these beliefs and associated practices were more time-efficient and might work better in heterogeneous classrooms.

In addition to teaching in heterogeneous classrooms, students' lack of interest in learning mathematics was a source of difficulty for the participants. The inservice participants attempted to manage the curriculum pace, heterogeneous classrooms, and lack of student interest by trying to increase student attitude and enjoyment in the mathematics classroom. One way to ensure the enjoyment was to make students like the teacher as a person: *"I mean, the teacher is an important factor. [The teacher] makes [the students] listen; [the students] should like the teacher. When the course is taught by* *a teacher that the student does not like, the student becomes [uninterested] in the course" (P2, 2004, Q19).* Most of the participants believed that there should be a good relationship between the teacher and the students so that the students would adopt a positive attitude towards learning mathematics.

The other way to increase student interest in the mathematics classroom was to provide the students with examples of the connection between mathematics and daily life issues. Inservice participants believed this connection to daily-life was crucial in learning mathematics, as P4 explained:

> *"When I build connections with the daily life, [the student] both understands and later extracts things from that [connection] [...] For a student to understand mathematics, [he/she] should be able to understand the examples I give, [I mean] the daily life examples" (P4, 2004, Q11).*

However, the connection between mathematical knowledge and daily life was rather in the form of an arithmetical tool for the participants. They claimed that they emphasized mathematics as a need in daily life skills for their students so that the students would have an interest in learning mathematics: *"[Students] should not see mathematics as a course, [rather, I wish they would think] 'This is useful for me in daily life, I will need this'" (P12, 2004, Q20).* Similarly, participants mentioned about the use of materials in the classroom for increasing student interest and enjoyment rather than their learning, as reported in the previous chapter.

In summary, the national curriculum pace that must be maintained in the classrooms where students lacked considerable mathematical knowledge seemed to lead the participants towards more teacher-centered beliefs and practices. However, they still considered student learning a priority and emphasized mathematics' connections to daily life in their teaching. By prioritizing student interest and enjoyment in teacher-centered classrooms in the first year of teaching, participants seemed to formulate ways to survive the curriculum pace and heterogeneous classrooms with an emphasis on student learning.

Summary

Inservice participants generally had teacher-centered beliefs both in 2003 and 2004 and the characteristics of these teacher-centered beliefs were quite similar across the participants in 2004 after the first-year of teaching. They generally claimed the effectiveness of teacher-centered practices in which few student-centered activities would be used, students' role is limited, and their interest in learning mathematics was considered. Two important phases of teaching that were the focus of this study, namely the teacher education program (EME program) and the first-year teaching, seemed to impact participants' mathematics related beliefs. This finding was consistent with previous studies (Flores & Day, 2006; Raymond, 1997), which found that preservice education and first-year in teaching influenced beginning teachers' teaching and learning beliefs in the contexts of Portugal and the U.S.

Participants seemed to believe in the effectiveness of students discovering the nature of mathematical concepts and use of materials in teaching mathematics at the end of their preservice education in the EME program. The participants claimed they mostly benefited from the PCK courses in the program and that they tried to use course materials whenever possible. Although they generally benefited from the program experiences, an extensive use of knowledge and skills gained in the program was not possible for them.

Besides lack of experience in real-classroom settings, contextual factors played role in rare use of program experiences in teaching.

Inservice participants had difficulties related to the tensions in classrooms such as management, a concern which many studies addressed (see Veenman, 1984). Curriculum pace was another important difficulty for the inservice participants since they did not practice teaching considering the pace and load of the curriculum. The lack of sufficient practice component in EME program was also effective on inservice participants as they could not realize the limitations of the curriculum until they started first-year teaching.

The impact of informal teaching experiences was an important finding in this study. Participants mostly had informal teaching experiences in the form of private tutoring or TPC teaching in which teacher-centered practices were valued. Moreover, they experienced especially TPC settings as a high-school student for at least one year while they were preparing for the university entrance exams, which served them with a considerable personal history. Informal teaching experiences seemed to influence inservice participants towards believing the effectiveness of teacher-centered practices in the mathematics classroom.

Participants' teacher-centered beliefs at the end of first-year teaching seemed to be partly formed through their experiences with the student population. Most participants had students with poor and unequal knowledge and skills in their classrooms. It was difficult for the participants to teach in such classrooms since they had to keep a pace with the national curriculum for which they were inspected. Additionally, they were not sufficiently prepared to teach in the heterogeneous classrooms in the EME program. Thus, participants were inclined to believe in the effectiveness of teacher-centered practices in the classroom since these practices seemed to work in their heterogeneous classrooms. In addition to having poor mathematical knowledge, participants' students did not have interest in learning mathematics. Hence, participants tended to emphasize mathematics' connections to daily life in the form of arithmetical tools in their teaching. They believed that such connection would increase student interest in mathematics, which they considered as a precondition for learning mathematics.

The participants claimed that emphasizing the connections between mathematics and the daily life would increase student interest and enjoyment in the mathematics classroom. Participants seemed to believe that student learning could be increased if their interest and enjoyment were increased and if students liked the teacher. They prioritized student enjoyment in the mathematics classroom and tended to use different approaches in teaching mathematics such as discovery and materials to increase student enjoyment rather than their understanding.

Inservice participants' rather unusual teacher-centered beliefs seemed to be a result of the transformation they experienced when they started to teach in real-classroom settings. It was difficult for the participants to import their EME program experiences to real-classroom settings since those experiences were shaped in somewhat artificial conditions where curriculum pace and student heterogeneity were not present. Thus, the participants re-considered these experiences through real-classroom conditions and re-formulated them in a way that would work both for maintaining curriculum pace and increasing student learning. In conclusion, participants expressed the impact of methods courses in the EME program on the way they considered mathematics teaching. These courses helped them to develop beliefs like effectiveness of using manipulatives in teaching and impact implementing different methods of teaching on students' mathematics learning. However, these beliefs were transformed to beliefs that considered the effectiveness of more teacher-centered beliefs in which some student-centered activities were used, teacher assumed the main responsibility, and students had limited duties while learning mathematics. First-year teaching did not provide contexts for the inservice participants in which student-centered beliefs would become more central in their belief systems.

CHAPTER 8

DISCUSSIONS AND IMPLICATIONS

Conducting this study and presenting the results have been a challenging process because of the highly subjective nature of beliefs. Although I tried to use the phrase "believe" with a less certain language, the theoretical framework I used and the consensus between the second coder and I provided me a safe space to conclude that the participants had certain beliefs. Our consensus was actually what we inferred from data within the limits of the theoretical framework.

Inferences from the data, or, in other words, what we concluded that participants believed, were documented in detail in the previous three results chapters. Results suggested certain points to emphasize in relation to the impact of EME program and first-year teaching experience. These points will be reviewed and discussed in this chapter with references to the previous studies. Although the title of the chapter addresses discussions and implications, this chapter initially documents conclusions, interpretations, and discussions of the findings. Some contributions and implications of the study will be mentioned in the first section, as well. Then the main contributions of the findings are summarized. The contributions of this study to my future career as a teacher educator and to educational research investigating teachers' beliefs are also explained. Although I give a detailed explanation of the limitations of the study in the Methods chapter, I will address it through the results of the study here as well.

Conclusions, Discussions, and Implications

In this section, first, EME program impact will be discussed based on the results from preservice and inservice participants' interviews. The focus will be on the practice of teacher education in the EME program, its role in the enculturation process in which preservice teachers' mathematics related beliefs are developed, and the differences between the U.S. context and the Turkish context in this process. Possible changes or improvements in the EME program practices are also addressed. Second, the impact of the first-year teaching experience and how it interferes with the EME program experiences will be discussed. The contributions and the implications of the present study are also emphasized through this section.

Effectiveness of EME Program

Teacher education programs are generally investigated for their effectiveness on changing preservice teachers' beliefs, mostly in terms of single course interventions. The present research addressed the impact of the program across multiple years to understand what preservice teachers in different year levels of the EME program believed and if there was any detectable impact of a certain year level or a certain course. The analysis of cross-sectional data of 2^{nd}-, 3^{rd}-, and 4^{th}-year participants showed that preservice teachers' beliefs about the nature of, teaching, and learning mathematics might not differ with respect to the year level in the program.

The lack of detectable difference in participants' beliefs through the year levels showed that EME program experiences might not have a significant impact on preservice teachers' beliefs. Two interrelated factors seemed to be the reason for the lack of impact. First, the courses were not specifically designed to challenge preservice teachers' beliefs;

such a lack of explicit focus on changing beliefs has been found to be ineffective in challenging preservice teachers' beliefs (Foss & Kleinsasser, 1996). Pedagogical content knowledge courses were generally considered by the Department faculty as having a content which preservice teachers would learn for the first time and find interesting and challenging. Different teaching approaches were introduced in these methods courses, but the courses did not explicitly challenge the preservice teachers' mathematics related beliefs and thus did not have a measurable impact on preservice teachers' beliefs in the present study.

A second explanation for the lack of effect of EME courses on preservice teachers' beliefs might be the practice of teacher education in the EME program. EME course experiences were mostly group presentations and projects of mathematics teaching methods or teaching of a certain mathematical concept. However, group presentations were mainly lectures about the teaching method or mathematical concept, presentation of few learning activities to the class pretending that it was a real-classroom context, but with no critical discussion of the presented teaching method or students' misconceptions in a specific mathematical concept. Only a few of the preservice participants referred to these course experiences during the interviews, although they were taking the course at the time of the interviews. Preservice participants generally perceived these presentations as less useful for their future teaching practice. It could be concluded that EME program course experiences might not have a strong or long-lasting impact on preservice participants' beliefs.

Despite the fact that no detectable changes occurred in preserve teachers' beliefs across the year levels in the present study, it should be noted that results of belief change studies should be interpreted with caution (Nettle, 1998). Even when there seems to be no overall impact of the teacher education programs or course interventions on preservice participants' beliefs, there might still be some change in few preservice participants' beliefs. In support of Nettle's view, the present analysis of preservice teachers' interviews did reveal minor changes, particularly when few Level 1 preservice teaching belief participants spoke (although infrequently) about implementing different mathematics teaching methods in the classroom.

Interestingly, although only few preservice participants referred to methods course experiences and contents during the interviews, inservice participants referred frequently to their program experiences, especially to the first methods course on teaching mathematics and the elective course on activity based teaching of mathematics, both when they graduated from the program and after their first-year of teaching. This might indicate a difference between preservice and inservice participants' program experiences and beliefs about teaching and learning mathematics.

The difference between the impact of EME program experiences on inservice and preservice participants' beliefs could be explained by opportunities of challenging course experiences that inservice participants had but preservice participants did not have due to the lack of sufficient number of faculty with mathematics education focus. Pajares (1992) claimed that beliefs were unlikely to change unless they were challenged. Although inservice participants complained about the lack of challenge in some of the EME program courses, most of them noted that there was challenge in two of the program courses: The first methods of mathematics teaching course and the elective course which was specifically designed to challenge inservice participants' beliefs about mathematics instruction at schools. Especially the elective course was designed to challenge the inservice participants and make them believe that mathematics teaching could be practiced in different ways at schools. Unlike other program PCK courses, the elective course had a variety of major innovative components such as creating and learning with mathematical games, using technological tools to understand mathematical concepts, and realizing mathematical misconceptions. These experiences encouraged inservice participants to reflect on their prior mathematics related beliefs and seemed to initiate a change. In contrast, preservice participants did not experience a course with these kinds of challenging components, which might account for the lack of belief change in preservice participants.

The lack of challenge in PCK courses addresses a more general problem of the EME program, which influences preservice teachers' experiences in the program. Although inservice participants had challenging course experiences in the EME program, these experiences were mostly limited to one course. However, belief change in the teacher education programs should be a continuous process of targeting and challenging beliefs through courses (Joram & Gabriele, 1998). The EME program lacked continuity and consistency of course contents and experiences, as addressed by most of the inservice participants. The inconsistency was mostly due to the change of professor in consecutive courses and the lack of communication among the professors who were teaching these courses. The present study showed that the EME program offerings might limit the nature of course experiences which would impact preservice and inservice teachers' mathematics related beliefs. The lack of sufficient number of professors in the program required recruiting faculty from other departments – faculty who were less familiar with the program and its goals and students. There was a lack of communication between the recruited professors and program faculty, which impacted the PCK course content and program students' experiences. This study highlighted the need for an increased number of faculty and continuous communication and reflection of teacher education practices among the course professors in order to influence preservice teachers' program experiences and the development of their mathematics related beliefs.

In addition to the EME program factors such as lack of continuity of challenge in courses, preservice teachers' informal teaching contexts seemed to decrease the impact of the program on participants' mathematics related beliefs. Teacher education program experiences constitute a very important component of the enculturation process in which preservice teachers' beliefs are considered to develop (Pajares, 1992). In the case of Turkey, there are other educational contexts such as TPC teaching and private tutoring, which impact preservice teachers' enculturation in addition to the teacher education programs. Understanding these contexts and experiences is important in understanding how preservice teachers' beliefs are formed. In the present study, exploration of the impact of informal teaching contexts also showed that these experiences might limit the enculturation process which the EME program was supposed to provide for the preservice teachers. Preservice and inservice participants of the present study mostly attended highly teacher-centered TPCs and private tutoring as pre-college students and then as tutors before they graduated from the EME program. Thus, teacher-centered informal teaching contexts continued to impact participants' mathematics related beliefs during their studies at the EME program. These contexts might interfer participants'

EME program experiences, which tended to emphasize student-centered practices in teaching mathematics.

The informal teaching experiences might have a large impact on participants' beliefs due to the lack of opportunities to practice teaching in the EME program courses. Methods course experiences were not practiced in real-classroom contexts immediately and practice teaching courses did not provide extensive teaching experience for the preservice teachers because they basically included observation of the school and classroom context instead of teaching. Preservice teachers were required to teach only two classes in the last semester of practice teaching, which could be extended only if the collaborating teacher offered more hours to teach. It seemed very likely that many participants in this study substituted their TPC teaching and private tutoring experiences for the classroom experiences that they felt the EME program should have provided. And recall that there is no "internship" in Turkey in teacher preparation programs. Being driven by their prior experiences and beliefs that considered teacher-centered practices as effective, many participants might have filtered the EME program experiences through these beliefs which reduced the impact of the program, similar to what Pajares (1992) has pointed out.

It has been noted that teacher education program experiences often do not prepare preservice teachers for the classroom realities (Wideen, et al., 1998). The present study found similar results. After their first-year teaching, inservice participants complained about the lack of sufficient teaching practice in the EME program. Although inservice participants attended three semesters of student teaching and almost all of them taught in informal teaching contexts for many years, participants felt that these teaching experiences were not effective in preparing them for the real-classroom contexts. Ryan (1979, as cited in Veenman, 1984) claimed that teachers are not necessarily fully trained in teacher preparation programs for what their work required.

One potential solution to this problem would be to lengthen the period of practice teaching of preservice teachers. However, longer student teaching might not prepare EME program students better for teaching at schools unless two important practices in teacher education would be changed or improved. First, the student teaching period should include more and continuous opportunities for preservice teachers to teach several mathematics concepts or a class through the semester, instead of teaching only two lessons in one semester. This would provide preservice teachers with more realistic experiences of classroom teaching where they would realize and deal with student differences, curriculum rush, and classroom management, compared to mostly irregular and disconnected classroom teaching in the EME program.

Second, methods courses should include an immediate microteaching component in which preservice teachers would experience the implementation of several student-centered approaches in real-classroom contexts throughout the courses. Since EME program students do not have the opportunity to implement methods course contents in microteaching immediately after the content is introduced, they tend to implement the course experiences during a very limited student teaching period which does not give sufficient insight into the reality of classroom teaching.

Previous studies in the U.S. showed that a short period of field experience during methods courses in which preservice teachers practiced skills emphasized in the courses did not change preservice teacher's beliefs (Foss & Kleinsasser, 1996; Nettle, 1998).

However and more recently, Ambrose (2004) provided support for the impact of having continuous and immediate practice opportunities (such as microteaching) on preservice teachers' beliefs. She found that an immediate, intense, and semester-long microteaching component in a content course for teaching mathematics to elementary school students helped preservice elementary teachers to develop new student-centered mathematics related beliefs.

Pedagogical content courses in teacher education programs in Turkey do not include any microteaching in which preservice teachers would practice student-centered methods of teaching mathematics in real-classroom contexts. As the Ambrose (2004) study suggests, an intense microteaching component for pedagogical content knowledge courses in EME programs could be considered as a promising intervention in impacting preservice teachers' beliefs. This type of extended microteaching for teacher education courses is not a magic bullet for developing higher level mathematics related beliefs. However, more microteaching of student-centered practices in real classrooms during preservice training could help Turkish preservice teachers gain more realistic understanding of the real-classroom contexts that might reduce the impact of reality shock on their beliefs. Through the microteaching component, Turkish preservice teachers might develop new student-centered beliefs and might be able to maintain some of these beliefs in their first years of teaching, since the impact of the first-year shock would be reduced by microteaching during the preservice training.

Comparison of U.S. and Turkish Preservice Teachers

So far, the conclusions, discussions, and implications of the present study have been presented and compared to previous studies mostly conducted in the U.S. However, it is useful to also present an explicit comparison of Turkish and U.S. preservice teachers' mathematics related beliefs and factors impacting these beliefs. Since there are considerable differences in the schooling and teacher education between U.S. and Turkey, it seems relevant to mention some emerging differences and similarities by comparing the results of the present study and previous findings of U.S. research.

The present study highlighted a difference in how U.S. and Turkish preservice teachers might make sense of what they experience in teacher education program experiences. While U.S. preservice teachers' prior beliefs are typically developed through their pre-college experiences as students (Lampert, 1990), Turkish preservice teachers' prior beliefs are developed both during their pre-college experiences as students and teaching experiences in TPC and private tutoring contexts as tutors. In other words, U.S. preservice teachers' beliefs are mostly observation-driven (based on what has been observed during time spent as a student), whereas Turkish preservice teachers' beliefs are both observation- and experience-driven (based both on observations as students and also on reflections on experiences as a teacher or tutor). Based on Green's (1971) characterization, one might argue that Turkish preservice teachers' prior and mostly teacher-centered beliefs (which emerge from TPC teaching and tutoring experiences) might be more central and would be more effective on their practice, since they become a part of their personal history through experience, as Nisbett and Rose (1980, as cited in Pajares, 1992) would suggest. Hence, for Turkish teachers, these teacher-centered beliefs might essentially 'filter' the teacher education program experiences more extensively compared to the U.S. preservice teachers' beliefs. The comparison is plausible; however, it is open to empirical investigation as no pattern was detected in preservice participants' beliefs in relation to differing amounts of TPC teaching and private tutoring experiences. Preservice participants with long versus no informal teaching experiences often had similar beliefs. Interestingly, inservice participants with longer TPC teaching experiences realized the impact of these experiences on their beliefs after the first-year teaching. In conclusion, although Turkish preservice teachers' prior beliefs were likely to be more central due to the informal teaching practices, the impact of these beliefs could not be generalized.

Summary

Teacher education programs are the contexts in which preservice teachers are expected to develop certain beliefs that will help them to promote learning for their future students. However, the effectiveness of these programs depends on many conditions such as the program offerings and the ways that preservice teachers process program experiences. The existing literature indicated a need for further research in order to understand the processes in which preservice teachers filtered the teacher education program experiences (Wideen, 1998). The present study investigated the enculturation process in which preservice teachers' mathematics related beliefs were formed in the context of an Elementary Mathematics Education program. It also explored the impact of informal teaching experiences on the teacher education program experiences and how these two sets of experiences affected participants' beliefs. Through investigating the beliefs of preservice and inservice (first-year) teachers, the present study reported the conditions and degrees of effectiveness of the EME program experiences in training middle school mathematics teachers. Considering that the program was initiated in 1998, this study provides a general initial program evaluation.

First-Year Teaching Contexts and Impacts

There is some evidence in the present study that beliefs impacted practice, a relationship that prior research has documented (see, Clark & Peterson, 1986; Nespor, 1987). Inservice teachers often expressed student-centered beliefs which considered students as capable of discovering important issues in mathematics. These student-centered beliefs might be attributable to the challenge inservice participants had in some of the EME program courses, as mentioned in the previous section. The impact of inservice participants' student-centered beliefs was evident in the description of their classroom practice where they allowed students discover mathematical concepts by the help of manipulatives. However, the underlying nature of such practices was teacher-centered, inconsistent with their student-centered beliefs.

Student-centered practices that inservice participants claimed to have in their classrooms were only a surface feature of their main practices. Participants explained concepts to the students and assumed most of the responsibilities in the classroom, which was inconsistent to their beliefs about the effectiveness of student-centered teaching practices. There may be three main explanations for this inconsistency: (i) existence of different clusters of beliefs, (ii) impact of broader schooling context, and (iii) the level of teachers' awareness of beliefs. These are explored here.

The first explanation concerns the existence of two main clusters of beliefs besides the belief levels, regarding mathematics instruction in the classroom in inservice participants' beliefs systems. One cluster seemed to be composed of the student-centered beliefs gained through the EME program experiences as explained above. The second cluster seemed to include teacher-centered beliefs that inservice participants would

consider as necessary to survive in the highly complicated classroom context. Although it might seem unusual to hold both teacher-centered and student-centered beliefs at the same time, Green (1971) claimed that beliefs are held in clusters, a condition which enables one to hold conflicting beliefs in different clusters. While some inservice participants seemed to gain many teacher-centered beliefs through informal teaching experiences during their EME program studies, many of the participants seemed to gain these teacher-centered beliefs as a result of their attempts to deal with contextual factors. The two clusters of beliefs might have impacted participants' practice depending on the students, curriculum, and available materials. Hence, the present study seemed to confirm the findings related to the inconsistencies between beliefs and practices of teachers because of the complexity of the classroom (Fang, 1996). This leads to the second explanation which might explain the inconsistencies in a broader context.

The second explanation, given by Ernest (1989), is that the social context including institutionalized curriculum, system of assessment, and national system of schooling cause teachers to have practices inconsistent with their beliefs. The curriculum is centralized at the national level and assumed to have a single pace for all the schools in Turkey, which are inspected every year. There are important common themes in schooling in Turkey such as the curriculum. However, schools, classrooms, teachers, and students are different in terms of availability of resources, the practice of previous teachers, and the level of students' knowledge. The present study showed that the inservice participants might not be ready to face these factors or limitations when they started their first-year teaching. Hence, they seemed to change their practice in the most efficient way that would maintain the curriculum pace, consider students' differences and learning, and use time efficiently. As a result, they started to have a hybrid of teacher-centered practices where they used surface features of student-centered practices.

The third explanation for the inconsistencies between inservice participants' student-centered beliefs and their mostly teacher-centered practices might be the lack of inservice participants' level of awareness of their beliefs, as suggested by Ernest (1989). The Turkish system, unlike the U.S. system, does not include an internship year in which teacher educators and schools monitor beginning teachers' practice and their learning of teaching. Although beginning teachers are assigned mentors who are experienced teachers and are responsible for monitoring and reflecting on beginning teachers' practices, mentors and beginning teachers meet on very rare occasions, or do not meet at all. Therefore, beginning teachers are mostly alone in their classrooms without any second opinion on their teaching, for which some participants expressed a need. Inservice (first-year) participants in this study were mostly assigned to rural schools where they were generally the only mathematics teacher. This might also reduce the possibility of having a community of practitioners who would form a support group for the inservice participants in their first-year. Inservice participants in the present study mostly lacked the reflection from peers and mentors about their beliefs and practices that previous studies (e.g., Aitken & Mildon, 1991) addressed as important for beginning teachers. The lack of constructive reflection on inservice participants' beliefs and practices enabled them to hold conflicting beliefs, a finding which previous studies addressed (e.g. Charalambous, Philippou, & Kyriakides, 2002; Schmidth & Kennedy, 1990; Thompson, 1984). Thus, inservice participants might have reflected on their own practice through their existing teacher-centered beliefs, rather than student-centered beliefs since they generally counted teacher-centered practices as effective, a finding consistent with previous studies (e.g. Flores & Day, 2006). Hence, inservice participants seemed to believe that student-centered practices which partly covered the actual teacher-centered practices were effective in teaching mathematics in the classrooms.

The three main explanations for the inconsistencies between inservice participants' student-centered beliefs and teacher-centered practices, which were clustered nature of beliefs, impact of context, and the awareness of belief, seemed to address two serious issues for preservice and inservice training. The first issue seemed to be the lack of immediate practice of learned skills and the insufficient student teaching experiences in the EME program as explained in the previous section. Inservice participants did not have sufficient opportunities during the EME program that they would practice their student-centered beliefs in real-classroom contexts. When inservice participants started to teach, they did not have opportunities which would support the development of their student-centered beliefs in their teaching-contexts. Therefore, they might have developed teacher-centered beliefs whose associated practices worked in the highly complex real-classroom settings. These teacher-centered beliefs about real-classroom contexts seemed to become more central in the everyday practice of inservice participants' maintaining curriculum pace and dealing with students' differences.

The second issue seemed to emerge as the perceived strength of the challenge which real-classroom contexts imposed on beginning teachers' beliefs and practices. Although inservice participants' beliefs seemed to be challenged in a program course and some student-centered beliefs were developed, these beliefs were re-challenged by the real-classroom contexts. The challenge of real-classroom contexts was perceived strong compared to the challenge of the EME program course perhaps because participants had to practice in the challenging context. Moreover, inservice participants initially might have highly unrealistic beliefs about the ways they would teach, as addressed by previous studies (Weinstein, 1989 and Wilson, 1990, as cited in Pajares, 1992). However, they seemed to have a reality shock in their classrooms where students lacked previous knowledge, schools lacked essential materials, and curriculum rush was the main concern of teaching. These factors seemed to lead a contradiction between inservice participants' ideal world and the real world (or their student-centered beliefs and teacher-centered practices), which was a universal concern for beginning teachers (Flores & Day, 2006; Veenman, 1984).

In summary, the three explanations for the inconsistency between inservice participants' student-centered beliefs and mostly teacher-centered practices and the two issues for the preservice and beginning years seemed to address that individual factors impacting beginning teachers' practice in the classrooms were impacted by other factors. Inservice participants' student-centered beliefs and unrealistic ideas about future teaching might be formed by the lack of sufficient real-classroom practices in the EME program. These beliefs and ideals were challenged by unexpected and unprepared context of schooling and inservice teachers were forced to survive in their first-year instead of practicing the skills they once were prepared and excited to implement. Schooling in Turkey seemed to promote teacher-centered beliefs for inservice participants, confirming the dominant impact of institutional factors on beginning teachers' practice as documented in prior work (Flores & Day, 2006; Raymond, 1997).

Policy Concerns for Beginning Teachers in Turkey

The present study highlighted a need for school re-organization in terms of curriculum, materials, and support groups. Although a new curriculum policy was initiated in Turkey beginning from 2005-2006 school year, this policy only considered decreasing the load (through increasing the high school education from 3 years to 4 years) and providing more time for student-centered practice. Even when the curriculum load would be reduced, students would likely to have a knowledge gap as a result of frequent teacher turnover existing at schools. Hence, beginning teachers would still have to deal with student differences for which they were not prepared in the teacher education programs. They would still lack self-reflection and second opinion opportunities through mentors and peers since the mentorship policy would not be effectively implemented.

A very important policy concern in teacher education in Turkey was also addressed in this study: the lack of communication between the teacher education programs and the Ministry of National Education on beginning teacher mentoring. Turkish beginning teachers are alone in their initial years. Some schools try to support beginning teachers through content-area teacher groups. However, this does not guarantee opportunities for reflection on beliefs, practices, and the inconsistencies between them, since experienced teachers' educational beliefs are rarely investigated and are very likely to be traditional. Similarly, even when mentors are interested in monitoring beginning teacher development, their beliefs, which are also likely to be very traditional, are not studied. Hence, an effective mentoring system including the collaboration of teacher education programs, schools, and mentors is needed in schooling in Turkey, in order to make beginning teachers reflect on their beliefs and practices and support them in their initial years. Such a mentoring system should start in the last year of teacher education programs in the form of communicating classroom reality to the preservice teachers. This is likely to reduce the impact of reality shock on beginning teachers' beliefs and practices. In this sense, the study confirms the suggestions presented in the literature that address 3-year monitoring of beginning teachers from the last year of preservice education (Aitken & Mildon, 1991).

Contributions of the Study

The contributions of this study are mostly expressed in the previous sections blended with discussions and implications. Here, I want to summarize the main points of the study's contribution in preservice education and beginning teacher support briefly. Although the study contributes to the research literature on teachers' beliefs generally, it also contributes to my own individual future practice of teacher education in the department where the study was conducted. I will address these contributions here. The contribution of the present study to the research on teachers' beliefs will be presented as well.

Teacher Education Programs and Initial Years in Teaching

The present study's main contribution is on the practice of teacher education in Turkey. It provides feedback from beginning teachers on the effectiveness of EME programs, which Turkish teacher educators have not attempted to gather through research. The present study also documents how preservice teachers' beliefs are developed in informal teaching contexts and how these beliefs may interfere with the EME program experiences. Generally, TPC and private tutoring contexts have been considered as a limiting factor in the development of preservice teachers' beliefs about learning mathematics as they promote solving a lot of questions correctly as success. However, prior to the present study, preservice teachers' informal teaching practices in especially TPC contexts have not been considered as a limiting factor for the teacher education program experiences and especially their beliefs about teaching mathematics. The present study shows that these contexts promote teacher-centered beliefs for preservice teachers by providing them a place to practice these beliefs. Hence, the study highlights a previously underestimated factor which decreases the desired impact of teacher education programs on preservice teachers' beliefs.

The results from the inservice participants provide a view of beginning teacher practice in national curriculum context – which has not previously been studied in depth. Although the national curriculum seems to provide a guide for the teachers and especially beginning teachers, it also has its own limitations and pressures, as documented in the present study. The curriculum pace and being inspected have always been concerns for teachers in Turkey. However, the concerns of beginning teachers seem to be different from experienced teachers since they are not experienced and they are generally assigned to rural schools in which teacher turnover was frequent. When beginning teachers start to teach in these schools, although their students lack essential previous knowledge, they are still expected to be on the same pace and inspected for that. Thus they face the dilemma of re-teaching previous concepts that students need to understand the new concepts and keeping the curriculum pace that they have not sufficiently prepared and they are inspected for. Therefore, the present study indicates that assigning beginning teachers to schools after the school year starts does not necessarily guarantee students' learning or teachers' effective teaching.

The present study documented the potential pitfalls of the national curriculum both for beginning teachers' teaching and students' learning, from the beginning teachers' point of view. Although the national curriculum provides guidance to the beginning teachers in the form of clearly stated concepts to teach and the learning objectives for the students, it brings limitations and difficulties due to other schooling and teacher recruitment policies. The present results are likely to contribute to the recent curriculum change in Turkey in terms of raising the attention of policy makers to the existing context and future impact of change in a more global sense including beginning teachers, students, and school contexts.

One of the most important outcomes of this study is the need for teacher preparation programs to explicitly challenge beliefs and encourage reflection on beliefs, in both preservice and beginning years. The EME program seems to have more impact on preservice teachers' beliefs when the courses challenge their beliefs more. The results of this study may be used for targeting preservice teachers' beliefs and organizing course experiences in a way to challenge those beliefs. Moreover, this study addressed a need for an effective mentoring system for the beginning teachers. The inservice participants expressed their need for a more knowledgeable person to address teachers' concerns about classroom management, teaching, and student differences. The study emphasizes that beginning teachers need mentors and opportunities for reflecting on their practice.

My Practice of and Research on Teacher Education

My main goal in conducting the present study was to contribute to the teacher education practice in the EME program, which also includes my practice as a future teacher educator. The present study provided me insight into the specific beliefs of preservice teachers. Since changing beliefs of preservice teachers is highly unlikely in the teacher education programs as documented by the present study, I will try to build on my students' existing beliefs through the courses that I will offer as Wideen et al (1998) suggests. This will definitely open a new window of research for me in terms of studying the effectiveness of my own teaching.

The present study provided me with convincing evidence from the inservice participants of the present study on the lack of effectiveness of EME courses and experiences. It confirmed my concern for the ineffectiveness of the general practice of teacher education in my College of Education. The present study gave me clues about potentially effective practices, such as making preservice teachers realize and reflect on their beliefs. It also helped me to identify missing or insufficient courses and experiences in the EME program. I communicated these issues and my suggestions for how these missing issues may be addressed to the EME program faculty (see Appendix E). Although the process of establish new courses and practices will take a long time, the process will provide a new area of research based on the present study's findings. The present study suggests a need for a more extensive longitudinal study concerning inservice participants' beliefs and practices. As I am still maintaining communication with the inservice participants of this research, I am planning to continue investigating their beliefs and practices as they get more experienced in teaching. Finally, the study highlighted the importance of effective constructive communication among the program faculty which I have been trying to establish and strengthen since the beginning of my doctoral studies.

Research on Teachers' Beliefs

In this study, a combination of three frameworks was used in order to analyze data and detect preservice and inservice participants' mathematics related beliefs. Two of these frameworks were developed empirically, implemented in U.S. and Finnish contexts and presented considerable consistency in investigating mathematics related beliefs. For this study, I added a third theoretical framework to make the first two frameworks stronger and implemented the combined framework in a Turkish context. The present study confirmed the findings in U.S. and Finnish contexts that characterized preservice and beginning mathematics teachers' beliefs mostly as Level 1 (Thompson, 1991; Lindgren, 1996). Hence, the study contributes to educational research by developing a comprehensive framework that can be used to investigate preservice and beginning teachers' mathematics related beliefs.

As mentioned in Chapter 2 (Literature Review), studies investigating teachers' beliefs state several methods that can be used in research. These methods vary in terms of what they conceptualize as "beliefs", how the beliefs are detected, and how they are justified. There is a general tendency in belief research to use study-specific definitions and methods which limit the consistency of findings with the previous studies and across different contexts as well as their implications. The framework used in the present study includes three frameworks that are consistent in terms of the general characterization of beliefs and the specific list of teachers' beliefs. Hence, the present study contributes to belief research in education by presenting a more accurate useful framework of teachers' beliefs which clarifies the process of detecting beliefs and has the potential to provide consistency across studies.

A future direction for the framework will be identifying contextual differences for Turkey and reorganizing it by adding or eliminating some belief statements. This process addresses both qualitative and comprehensive quantitative studies which will be based on the present study.

In summary, the implications of the study for the field of teacher education address three major issues. First, teacher education program experiences, which teacher educators might consider as eye-opening, may not impact the preservice teachers as intended. Hence, investigating teachers' beliefs from the beginning of teacher education programs might enable teacher educators to evaluate the impact of the program experiences and to plan necessary courses and experiences that would challenge and even change the beliefs. Second, contextual differences might result in different paths where preservice and inservice teachers develop mathematics related beliefs. Findings from a highly decentralized system such as the U.S. system should not be generalized to the highly centralized system of Turkey. Moreover, countries have different teacher education programs and cultures of teaching and learning which are likely to impact preservice teachers in different ways. This study shows that in order to investigate and compare certain issues common to all educational systems, such as teachers' beliefs, there is a need for an initial investigation of each system's nature in every level so that the impact of structural differences would be documented and a discussion base could be formed. Third, using more definite tools in different settings for data analysis in qualitative research of highly subjective constructs might enable researchers to reach a consensus on a working tool that is open to improvement. This might also address the impact of cultural and systemic differences that are likely to appear in teachers' beliefs.

APPENDIX A

MATHEMATICS RELATED BELIEFS FRAMEWORKS

Complete list of Characterizations in Thompson's (1991) Framework

Table A.1
Thompson's (1991) Framework that Characterizes Mathematics Related Belief Levels.

Levels	Characterization
Level 0	• Mathematics is basically the usage of arithmetic skills in daily life. • Mathematical knowledge is composed of facts, rules and procedures. • The goal of the mathematics instruction is to obtain the correct/accurate answer, through the ways demonstrated in the class. • Mathematics teaching is developing students' arithmetic skills through memorization of rules without mentioning relationships among them. • Textbook is followed to teach mathematics without considering relevancy of the concepts. • Teacher's role is to demonstrate the procedures as mathematical knowledge. • Student's role is to imitate and extensively practice the procedures the teachers had just demonstrated. • There is an authority, either the teacher or the text book, for the correctness/accuracy of mathematical knowledge.
Level 1	• Mathematics is composed of rules and procedures with the principles behind them. • The distinction between the meanings and skills in the mathematical concepts has just initiated. • Conceptual analysis of content domains and appreciation of complexity of mathematical content has just started. • Teaching through manipulatives is associated with attitudinal goals and empirical justification rather than cognitive goals and making connections to mathematical concepts. • Teaching for conceptual understanding is using pedagogical tasks and instructional representations to explain isolated sets of concepts and procedures. • Problem solving is taught separately from the mathematical content. • Integrating problems in the content means spreading problems unrelated to the content. • Teaching "about" problem solving (i.e. selection of strategies) takes place rather than teaching "with" problem solving (i.e. using it as an instructional approach). • Pedagogical decisions are based on perceptions of experts rather than cognitive effectiveness of instructional practices. • Students put effort to understand the justification of the mathematical procedures. • Experts are still an authority for the correctness/accuracy of the mathematical procedures.
Level 2	• The importance of various concepts and centrality of various ideas in mathematics are realized through understanding the relationships between them. • Proof and generalization processes are considered as a part of mathematics teaching and learning. • Visual and concrete representations are designed to provide students contexts that they can explore their ideas. • Teachers guide and provide opportunities for students' understanding through carefully designed pedagogical approaches. • Student-generated ideas are considered as important. • Students must involve in constructing mathematical ideas in order to understand them better. • The goal of instruction is develop students' reasoning through investigating mathematical ideas.

Complete List of Characterizations in Lindgren's (1996) Framework

Table A.2

Lindgren's (1996) Framework that Characterizes Mathematics Related Belief Levels.

Levels	Characterization
Rules and Routines (*Level 0*)	• Above all one should teach mathematical knowledge i.e. facts, rules, and statements. • When solving problems, it is most important that the students get the right answers. • In teaching one should use as often as possible such routine problems, where the correct answer can be achieved by using a familiar method. • In learning mathematics, it is most important that pupils practice extensively. • Above all, the pupils should learn to master basic calculation. • The most important task for the teacher is to maintain good order in the class.
Discussion and Games (*Level 1*)	• Above all the teacher should try to promote active class discussions. • In the math class one has to emphasize individual work. • In teaching mathematics, the teacher should let the students use many learning games. • In the teaching process one should promote the pupil's ability to work with other pupils.
Open-Approach (*Level 2*):	• The student should have the possibility to experience that the same result can be achieved in different ways. • The teacher should encourage the students to find different strategies for solving problems, and to discuss these strategies. • The pupils should have a possibility to formulate problems by themselves and then solve them. • The students should use concrete manipulatives as often as possible. • In teaching mathematics one should use many verbal problems where the student must apply his knowledge. • One should use, as often as possible, problems where the student has to think first, and where the mastery of calculation alone will not lead to the solving of the problem. • During math lessons one should emphasize the importance of mathematical thinking. • One should consider the possible situations for the use of computers in the teaching of mathematics.

Complete List of Characterizations in Ernest's (1989) Framework

Table A.3
Ernest's (1989) Model that Characterizes Mathematics Related Belief Levels.

Models	Levels
Conception of Nature of Mathematics	• *Instrumentalist View*: Mathematics as a set of tools that include unrelated facts, rules and skills used in order to reach an external end product • *Platonist View*: Mathematics as a static but combined body of knowledge, in which there are structures and truths connected to each other by logic and meaning. Mathematics is not created but discovered • *Problem-solving View*: Mathematics as a dynamic, problem-driven, continually expanding field in which there is a process of knowledge generation. Mathematics is not seen as a finished product
Models of Teaching Mathematics	• the day to day survival model • the mastery of skills and facts model • the mastery of skills and facts with conceptual understanding model • the conceptual understanding model • the conceptual understanding enriched with problem-solving model • the pure investigational, problem posing and solving model
Models of Learning Mathematics	• child's complaint behaviour model. • child's linear progress through curricular scheme model • child's mastery of skills model • child's constructed understanding driven model • child's constructed understanding and interest driven model • child's exploration and autonomous pursuit of own interests model

Table A.4

Complete List of Level 0 Beliefs (T: Thompson's (1991); L: Lindgren's (1996); E: Ernest's (1989)).

Nature of Mathematics	• Mathematics is basically the usage of arithmetic skills in daily life (T). • Mathematical knowledge is composed of facts, rules and procedures (T) (L). • The goal of the mathematics and problem solving is to obtain the correct answer, usually in the ways demonstrated in the class (T). • There is an authority, either the teacher or the text book, for the mathematical knowledge (T). *Instrumentalist view*: Mathematics as a set of tools that include unrelated facts, rules and skills used in order to reach an external end product (E).
Teaching Mathematics	• Mathematics teaching is developing students' arithmetic skills through memorization of rules without reasoning (T). • Textbook is followed to teach mathematics without considering relevancy of the concepts (T). • Teacher's role is to demonstrate the procedures as mathematical knowledge (T). • Above all one should teach mathematical knowledge i.e. facts, rules, and statements (L). • In teaching one should use as often as possible such routine problems, where the correct answer can be achieved by using a familiar method (L). • The most important task for the teacher is to maintain good order in the class (L).
Learning Mathematics	• Student's role is to imitate and practice the procedures the teachers had just demonstrated (T). • When solving problems, it is most important that the students get the right answers (L). • In learning mathematics, it is most important that pupils practice extensively (L). • Above all, the pupils should learn to master basic calculation (L).

Table A.5

Complete List of Level 1 Beliefs (T: Thompson's (1991); L: Lindgren's (1996); E: Ernest's (1989)).

Nature of Mathematics	• Mathematics is still composed of rules but the principles behind the rules are also considered (T). • The distinction between the meanings and skills in the mathematical concepts has just been realized (T). • Integrating problems in the content means spreading problems unrelated to the content (T). • There is an authority for the correctness of the accuracy of the mathematical procedures (T). • *Platonist view*: Mathematics as a static but combined body of knowledge, in which there are structures and truths connected to each other by logic and meaning. Mathematics is not created but discovered (E).
Teaching Mathematics	• Mathematics teaching includes the use of instructional representations and manipulatives (T). • Teaching through manipulatives is seen as a way to make mathematics more fun rather than a way to achieve cognitive goals (T). • Teaching for conceptual understanding is using pedagogical tasks to explain isolated sets of concepts (T). • Problem solving is taught separately from the mathematical content (T). • Integrating problems in the content means spreading problems unrelated to the content (T). • Teaching "about" problem solving (i.e. understanding of strategies) takes place rather than teaching "with" problem solving (i.e. using it as an instructional approach) (T). • Role of the teacher is similar to the roles described in Level 0 (T). • Above all the teacher should try to promote active class discussions (L). • In the math class one has to emphasize individual work (L). • In teaching mathematics, the teacher should let the students use many learning games (L). • In the teaching process one should promote the pupil's ability to work with other pupils (L).
Learning Mathematics	• Students put effort to understand the justification of the mathematical procedures (T).

Table A.6

Complete List of Level 2 Beliefs (T: Thompson's (1991); L: Lindgren's (1996); E: Ernest's (1989)).

Nature of Mathematics	• The importance of various concepts and centrality of various ideas in mathematics are realized (T). • *Problem-solving view*: Mathematics as a dynamic, problem-driven, continually expanding field in which there is a process of knowledge generation. Mathematics is not seen as a finished product (E).
Teaching Mathematics	• Mathematics teaching means understanding through doing mathematics where students are engaged (T). • Proof and generalization processes are considered as a part of mathematics teaching (T). • Visual and concrete representations are designed to help students explore their ideas (T). • Student-generated procedures are valued (T). • Teachers guide students' thinking and allow students to express their ideas in order to have a better understanding of their learning process (T). • The teacher should encourage the students to find different strategies for solving problems, and to discuss these strategies (L). • In teaching mathematics one should use many verbal problems where the student must apply his knowledge (L). • One should use, as often as possible, problems where the student has to think first, and where the mastery of calculation alone will not lead to the solving of the problem (L). • During math lessons one should emphasize the importance of mathematical thinking (L). • One should consider the possible situations for the use of computers in the teaching of mathematics (L). • Concrete manipulatives should be integrated in the teaching as often as possible (L).
Learning Mathematics	• Students engage in doing mathematics in order to understand (T). • Proof and generalization processes are considered as a part of mathematics learning (T). • Students express their ideas (T). • The student should have the possibility to experience that the same result can be achieved in different ways (L). • The pupils should have a possibility to formulate problems by themselves and then solve them (L). • The students should use concrete manipulatives as often as possible (L).

APPENDIX B

ELEMENTARY MATHEMATICS EDUCATION PROGRAM DETAILS

Elementary Mathematics Education Program Courses

The following list gives the Elementary Mathematics Education program and the descriptions of the courses offered by the Department of Elementary Education. The first number in the parenthesis refers to the class hours and the second number refers to the application or laboratory hours. The number out of the parenthesis refers to the total credit of the course calculated by adding the class hours with the half of the application/laboratory hours.

Courses by Semester

1st Year, First Semester
MATH 111 Fundamentals of Mathematics (3-0)3
MATH 151 Calculus I (4-2)5
PHYS 181 Basic Physics I (4-2)5
ENG 101 Development of Reading and Writing Skills I (4-0)4
EDS 119 Introduction to Teaching Profession (3-0)3
IS 100 Introduction to Information Technologies and Applications NC

1st Year, Second Semester
MATH 112 Introductory Discrete Mathematics (3-0)3
MATH 152 Calculus II (4-2)5
PHYS 182 Basic Physics II (4-2)5
ENG 102 Development of Reading and Writing Skills II (4-0)4
ELE 132 School Experience I (1-4)3

2nd Year, Third Semester
MATH 115 Analytical Geometry (3-0)3
MATH 201 Elementary Geometry (3-0)3
CHEM 283 Introductory General Chemistry (3-2)4
EDS 221 Development and Learning (3-0)3
ENG 211 Academic Oral Presentation Skills (3-0)3
HIST 2201 Principles of Kemal Ataturk I NC

2nd Year, Fourth Semester
MATH 116 Basic Algebraic Structures (3-0)3
MATH 255 Introduction to Differential Equations (4-0)4
BIO 106 General Biology (3-0)3
ELE 224 Instructional Planning and Evaluation (3-2)4
ELE 300 Computer Applications in Education (2-2)3
HIST 2202 Principles of Kemal Ataturk II NC

3rd Year, Fifth Semester
MATH 260 Linear Algebra (3-0)3
ELE 317 Instructional Development and Media in Mathematics
Education (3-2)4
ELE 331 Laboratory Applications in Science I (2-2)3
TURK 305 Oral Communication (2-0)2
Elective I (3-0)3, Elective II (3-0)3

3rd Year, Sixth Semester
ELE 240 Probability and Statistics (2-2)3
ELE 332 Laboratory Applications in Science II (2-2)3
ELE 336 Methods of Science and Mathematics Teaching (3-2)4
EDS 304 Classroom Management (2-2)3
TURK 306 Written Communication (2-0)2
Elective III (3-0)3

4th Year, Seventh Semester
ELE 437 School Experience II (1-4)3
ELE 443 Methods of Mathematics Teaching (2-2)3
ENG 311 Advanced Communication Skills (3-0)3
Elective IV (3-0)3, Elective V (3-0)3

4th Year, Eighth Semester
ELE 420 Practice Teaching in Elementary Education (2-6)5
ELE 448 Textbook Analysis in Mathematics Education (2-2)3
EDS 424 Guidance (3-0)3
Elective VI (3-0)3

ELE 132 School Experience I (1-4)3
Classroom observation including organization and management of school, daily activities in the school, group activities, a day of a teacher, a day of a student, school-family cooperation, observation of major and non-major courses, school and related problems, various teaching learning activities, examination of materials and written sources.
ELE 224 Instructional Planning and Evaluation (3-2)4
Basic concepts in curriculum development and its processes; development of lesson plan, unit plan, annual and daily plan; selection of content and organization. Teaching methods and strategies; properties of materials and their selection; measurement and evaluation; approaches in evaluation; types of tests; developing achievement tests.
ELE 240 Probability and Statistics (2-2) 3
Data collection, sampling, sampling distribution and estimation, permutation and combination, probability, continuous random variables and distribution, estimated value, data analysis, hypotesis testing, Chi-square test, regression and correlation.
ELE 300 Computer Applications in Education (2-2)3
Develop proficiency with networked workstations and computer applications. Provides experience with word processors, spreadsheets, presentation software and the Internet. Focuses on the principles and specific ideas for appropriate, responsible, and ethical computer use. Promotes self-confidence for on-going professional development.
ELE 331 Laboratory Applications in Science I (2-2)3
Laboratory experiments in science education. Improvement of skills in setting up experiments in science courses for elementary schools through 6-8.
ELE 332 Laboratory Applications in Science II (2-2)3
Continuation of ELE 331
ELE 317 Instructional Development and Media in Math Education (3-2)4
Characteristics of various instructional technologies, the place and use of technologies in instructional process, development of teaching materials through instructional technologies (worksheets, transparencies, slides, videotapes, computer-based course materials, etc.), and assessment of the qualities of various teaching materials.
ELE 336 Methods of Science and Mathematics Teaching (3-2)4
Concepts of methods and teaching strategies in elementary education. Different methods of instruction, such as expository, inquiry, discovery, demonstration, discussion, problem solving and cooperative learning as applied to the teaching and learning process in teaching science and mathematics at elementary schools.
ELE 420 Practice Teaching in Elementary Education (2-6)5
Field experience and teaching practice (minimum 12 weeks) including class observation, adaptation to classroom condition, planning and preparation for teaching. Guided teaching practice in science in elementary schools
ELE 437 School Experience II (1-4)3
Continuation of ELE 132.
ELE 443 Methods of Mathematics Teaching (2-2)3
Concepts of methods and teaching strategies in elementary education. Different methods of instruction, such as expository, inquiry, discovery, demonstration, discussion, problem solving and cooperative learning as applied to the teaching and learning process in teaching mathematics at elementary schools.
ELE 448 Textbook Analysis in Mathematics Education (2-2)3
Examination of subject matter course books and educational programs, approved by Ministry of Education, in terms of student's level, content, language, format, and contribution to meaningful learning.

ELE 132 School Experience I

Course Description

The school experience gives time for student to assimilate their experience to relate them to the work being done at the Faculty, and to discuss them with staff and other students. Therefore, it provides opportunities for an increase in professional competence.

General Rules

- 4 hours attendance to your cooperating school (total 40 hrs)
- Doing the activities asked by teachers.
- Attendance to the one hour course in the campus
- Complete required assignments and reports on time.

Late Assignments

I expect that assignments will be turned in by the announced due dates. I will accept assignments after the due date, but your grade will decrease by 10% of the allocated points for each calendar day the assignment is late.

Assignments must be submitted both in printed (hard copy) and electronic (soft copy) form. To send assignments in electronic form use following e-mail address: ele132@gmail.com

Academic Ethics:

All assignments you hand in should be the result of your effort only. Academic dishonesty, including any form of **cheating** and **plagiarism** will not be tolerated and will result in failure of the course and/or formal disciplinary proceedings usually resulting in **suspension** or **dismissal**. Cheating includes but is not limited to such acts as; offering or receiving unpermitted assistance in the exams, using any type of unauthorized written material during the exams, handing in any part or all of someone else's work as your own, copying from the Internet. Plagiarism is a specific form of cheating. It means using someone else's work without giving credit. Plagiarism is a literary theft. Therefore, you have to acknowledge the sources you use in your assignments.

Grading

Grading will be based on the projects and assignments. The list of the major assignments is given below. The details of each project/assignment will be provided to you during the semester.

Activity	**Percent**
Report 1	20
Report 2	25
Report 3	20
Report 4	20
Journal Writing	10
Field Notes & Reflection	5

Course Requirements

Attendance: Full attendance is expected to all required classroom visits. The purpose for field experience is to give you an opportunity to observe and reflect upon teaching. Successful completion of ELE 132 includes completing a minimum of 4 hours of classroom observation/participation per week.

Field Notes: You are expected to keep a notebook that includes your field notes. Your reports should be based on your field notes. Each week, you should show your field notes to one of the instructors. At the end of the semester, you are expected to submit your notebooks.

Journal writing: You should maintain journals of your day to day experiences. The purpose of the journal is to allow you to reflect upon and synthesize your learning experience and your attitudes, keeping in mind the concepts of "writing for learning". The following questions may guide you: *(Maximum 2 pages-double spaced, 12 pts; total 5 journals):*

- What did you observe? (A general description of your observations)
- What was the most striking/ interesting classroom event that you observed?
- What confused you?
- What was new learning to you? / What discoveries are you making?

- What lessons did you learn from this experience as a prospective teacher?

The due date will be announced. Late reports will not be accepted.

Reflection Paper: Based on your observations throughout the semester, prepare a reflection paper. This should be a two to four page synopsis of the overall **experience** that includes the following three elements:

- Fully describe one specific meaningful **experience** and reflect on it's impact related to your growth as a teacher in training.
- How has this **experience** effected your decision to pursue a career as a teacher? Include information related to working with this grade level.
- Indicate the grade you feel you earned for this course and why.

Reports: During the semester, you are expected to write 4 different reports. The content and the format of these report will be explained.

Required Reports for ELE 131

Report 1: Planning for Mathematics Instruction

This report should include a description of how the curriculum is implemented in this school. The followings are some of the issues that you may discuss in your reports.

- How school and teacher plan the mathematics instruction? What resources do they use in planning and preparing the instruction? Are there any additions or revisions that school made in the curriculum (if yes , what are they, and why they are doing it)? What are the formats for daily and yearly plans?
- What materials are available for mathematics instruction (computers, laboratories, library, and others)? How frequently are they used? For what purpose are they used? How are they used (a description of the procedure)?
- What are the major characteristics of the textbooks? How textbooks are selected? What is the procedure they use in selecting textbooks?
- Is there any mathematics department in your school? How does it work? What are the teachers' responsibilities in the department? How they make decisions in the department meetings? etc.

NOTE: Your report should not be limited to the questions given here. You should try to expand these issues.

Report 2: Mathematics Lessons

This is a report about mathematics lessons. The report should describe the conduct of mathematics lessons, including a description of the kind of work done, interactions, assessment procedures, habits, and such major characteristics of a mathematics lesson. The followings are some of the issues that you may discuss in your reports.

- How teaching takes place? What is/are the method(s) teacher use in mathematics lessons? How s/he uses these methods (a description of the procedure)? Are there any traditions/habits of teacher in mathematics lessons? How does s/he assess student learning? Are there any specific materials that teacher use (overhead projector, worksheets)? etc.
- How learning takes place? What are the expectations from students during, before, and after the lessons? What kind of interaction exists among students and between students and the teacher during math lessons? Are there any common learning problems?
- How the classroom management handled? What specific methods does teacher use to handle the misbehavior? How does s/he manage the orderliness of the lesson during teaching?

NOTE: Your report should not be limited to the questions given here. You should try to expand these issues.

Report 3: Other Aspects of School

In this report you need to write about the other activities of the school, such as general rules, services, clubs, sports, and etc.

- A description of school family cooperation
- Student clubs and some of their typical activities
- Counseling service and other services
- The rules of the school
- Infrastructure

- Specific and unique aspect of the school.

NOTE: Your report should not be limited to the questions given here. You should try to expand these issues.

Report 4: Mathematics Teacher Interview Report

In this assignment you will interview your mentor teacher. The focus of this interview is to learn about duties and responsibilities of a mathematics teacher related to teaching and other school tasks. The following are some of the questions you should ask. You may also add your own questions to the question list.

- Why did you select teaching as a career?
- What are your teaching responsibilities in this school?
- What are the responsibilities towards mathematics department?
- What are the responsibilities during the duty on?
- What is a typical day for you? Can you describe your daily routine tasks?
- What are the difficulties of being a mathematics teacher?
- What is most exciting about teaching mathematics?
- What kind of roles does teacher have in extra curricular mathematics activities?
- What kinds of resources are available for you (both within the school and outside the school)?
- What do I most need to know to be an effective classroom teacher?
- What do you consider two of the most important characteristics to be a competent teacher?

NOTE: Your report should not be limited to the questions given here. You should try to expand these issues.

The procedures you should follow during interviews:

Study your questions before you ask to the teacher. Try to anticipate teacher responses and ask more questions to reveal more information. For instance, if the teacher says "teaching mathematics is stressful" and doesn't say anymore, ask to him/her "what makes mathematics teaching stressful? You need to carefully listen to the teacher's answers and take notes to your notebooks. During the interview if you need more time to write down your notes, ask the teacher to wait for a while. It can be also helpful to you, if you practice an interview with one of your friends.

Report Format

Reports should be written by using MS-Word and submitted in both printed and electronic form. At the end of the semester you will have 4 reports. The following plan should be followed in your report, in the given order:

1. Cover page: See sample cover page.
2. Introduction
   - Write about the general purpose of the report.
   - Indicate specific questions that you are going to address in this report (if applicable)
   - Explain the importance/value of the issue(s).
   - Include information about how you collected information about this report in detail.
   - Where did you get the information?
   - How did you get it?
   - How long it took to get the information and when did you collect data?
   - Other relevant information related to your data/information collection procedures.
3. Description and Interpretation of collected information/data
   - Include a description of what you observed/obtained from the school about this report. For each peace of information you present, include your interpretations. In this part you may use sub titles related to the topic of your report.
4. Discussion, conclusion, and reflection
   - Discuss each information/data you obtained. Can you generalize your findings? Why? Why not?

Reflect on how your findings influenced your thinking about being a teacher.

ELE 224 Instructional Planning and Evaluation

Goals

The purpose of this course is to study on the issues around planning for instruction and assessment in the elementary school mathematics and science. The course content includes a review of broader perspectives about curriculum development. Upon the completion of this course, we expect that our students

- Understand the basic concepts related to curriculum.
- Understand instructional objectives at various levels of cognitive, affective, and psychomotor domains.
- Have a critical perspective on the curricular experiences in Turkey.
- Develop plans for instruction (lesson plans and unit plans).
- Understand basic concepts related to assessment and measurement.
- Understand the issues that make a well designed instrument for classroom evaluation.
- Develop various assessment materials for the classroom use.

Grading and Assignments

Mid-term exam: There will be one mid-term examination. The exam will cover information presented in class and in the readings.

Final Exam: There will be a comprehensive final exam. The final will include questions that are covered during the entire semester.

Project: Details of the project will be announced during the semester.

Presentation of Teaching Methods and Summary paper: You will be asked to make presentation about the assigned teaching methods in groups of 3 or 4. The presentations will be about 10 -15 minutes. You will also be asked to prepare a "summary paper" that outlines the major characteristics of teaching methods.

Quizzes: There will be two quizzes during the semester. Date of each quiz will be announced in advance (a week before the date).

Mid-term	25%
Project	15%
Presentation	10%
Quizzes	10%
Final	40%

Academic Ethics:

All assignments you hand in should be the result of your effort only. Academic dishonesty, including any form of **cheating** and **plagiarism** will not be tolerated and will result in failure of the course and/or formal disciplinary proceedings usually resulting in **suspension** or **dismissal**. Cheating includes but is not limited to such acts as; offering or receiving unpermitted assistance in the exams, using any type of unauthorized written material during the exams, handing in any part or all of someone else's work as your own, copying from the Internet. Plagiarism is a specific form of cheating. It means using someone else's work without giving credit. Plagiarism is a literary theft. Therefore, you have to acknowledge the sources you use in your assignments.

Required Texts:

Marsch, J. C. & Willis, G. (1999). *Curriculum: Alternative Approaches, Ongoing Issues.* Upper Saddle River, NJ: Merrill (Chapter 1 & 2).

Clark, L. H. & Starr, I. S. (1996). *Secondary and Middle School Teaching Methods.* New Jersey: Prentice Hall (Chapter 5 & 6).

Zook, K. (2001), *Instructional Design for Classroom Teaching and Learning.* Boston: Houghton Miffling Company. (Chapter 4 & 5).

Linn, R. L. & Gronlund, N. E. (2000). *Measurement and Assessment in Teaching.* New Jersey: Prentice Hall (Chapter 4 & 5).

Tentative schedule

Weeks

Week 1	Introduction, overview.
Week 2	Basic concepts of curriculum *Reading 1: Marsch & Willis (1999), Chapter 1*
Week 3	Curriculum development process *Reading 2: Marsch & Willis (1999), Chapter 2*
Week 4	Planning for teaching *Reading 3a: Clark & Starr (1996), Chapter 5* *Reading 3b: Callahan, Clark & Kellough (p. 109-123)*
Week 5	Planning for teaching (continued)
Week 6	Course unit and lesson planning *Reading 4a: Clark & Starr (1996), Chapter 6* *Reading 4b: Tebligler dergisi (in Turkish)*
Week 7	Teaching methods *Reading: Handouts*
Week 8	Student presentations about assigned teaching methods
Week 9	Principles of classroom assessment *Reading 5: Zook (2001), Chapter 4*
Week 10	Issues of validity and reliability *Reading 6 & 7: Linn & Gronlund (2000), Chapter 4 & 5*
Week 11	Issues of validity and reliability *Reading 6 & 7: Linn & Gronlund (2000)*
Week 12	Classroom Assessment Strategies *Reading 8: Zook (2001), Chapter 5*
Week 13	*Alternative Assessment* *Reading: Handouts*
Week 14	Wrap Up

ELE 317 Instructional Development and Media in Mathematics Education

Course Goals

Upon the completion of this course I expect the students to be able to:

- Engage in the preliminary steps of instructional material development using computer applications.
- Use basic tools for creating computer-mediated learning modules and be confident in using them.
- Use effective message design in the creation of instructional materials. In addition, you are expected to show sensitivity to ethical issues and concerns.

Method of Instruction

ELE 329 is a lab-based course. The role of the instructor is to guide students through experiences that allow you to complete the project assignments of the course, and to act as a facilitator and supporter of your learning. Your success will be directly related to how much time and energy you put into the class, and your willingness to try new things. Do not expect things to run smoothly: the computers will crash, files will be corrupted, and other bad things will happen. Dealing with these situations is part of the class, and your ability to deal with them will impact your success in the class.

You are expected to take responsibility for your own learning and be willing to experiment with new technologies; to work with your classmates and the instructor to create a positive learning environment; to study assigned readings prior to each class session; to participate in class discussions and learning opportunities; and to complete all assignments on time and with the highest quality possible.

Content Outline

Media, Technology, and Learning
Visual Principles
Technologies for Learning
Systematic Planning for Media Use
Media and Materials
Visuals
Internet and WWW

Attendance and Participation

You are expected to demonstrate energetic, high quality performance in all aspects of this course. Regular attendance is expected and required in the laboratory sessions. Your attendance and participation in laboratory sessions will be reflected in your lab grades.

Late Assignments

I expect that assignments will be turned in by the announced due dates. I will accept assignments after the due date, but your grade will decrease by 10% of the allocated points for each calendar day the assignment is late.

Grading

Grading will be based on the projects, assignments, and a midterm examination. The list of the major assignments is given below. The details of each project/assignment will be provided to you during the semester.

	%
Midterm	30
Poster	15
Spreadsheet Project	15
Web Site	20
Reflection Paper	5
Lab work (attendance, assignments, etc)	15

Week of	Topic and Assignments
Sept, 28	Course introduction and overview of the objectives. Media, Technology, and Learning Reading 1: Heinich (2002), Chapter 1
Oct, 5	Visual Principles Reading 2: Heinich (2002), Chapter 5 *Poster design project introduced*
Oct, 12	Technologies for Learning Reading 3: Heinich (2002), Chapter 2
Oct, 19	*Poster project due* Learning from this project – An open show of posters
Oct, 26	Systematic Planning for Media Use Reading 4: Heinich (2002), Chapter 3 *Spreadsheet project introduced*
Nov, 2	Media and Materials Reading 5: Heinich (2002), Chapter 4
Nov, 9	About the use of spreadsheets in mathematics education. *Midterm will be done in this week. Date will be announced*
Nov, 16	Holiday
Nov, 23	Learning from this project – Presentation of selected projects. *Spreadsheet project due*
Nov, 30	Visuals Reading 5: Heinich (2002), Chapter 6
Dec, 7	About Internet and WWW. *WWW project introduced*
Dec, 14	Creating HTML documents and publishing in METU servers.
Dec, 21	Evaluating content on WWW.
Dec, 28	Reflections about experiences.

ELE 336Methods of Math and Science Teaching

Course Description:

This course is aimed to have preservice teachers develop skills in methods of teaching science mathematics to 4^{th}-8^{th} grade level students. It focuses on the issues around what can be done to help young learners understand the science and math concepts. There will be an emphasis on critical discussion and applications of each of the teaching strategy that are covered.

Course Objectives: At the end of the semester students should able to;

1. be aware of specific teaching methods that can be used in 6-8 mathematics and science instruction.
2. critically review a given teaching strategy.
3. engage students in a discourse to help them understand mathematics and science ideas.
4. select appropriate teaching approach to design an effective learning environment.
5. communicate about teaching and learning and work cooperatively on projects related to teaching.
6. Be self-confident in mathematics/science teaching methods.
7. Enjoy teaching mathematics/science.

Course Requirements

Attendance: The nature of the class activities and course objectives make attendance important. For that reason, attendance is required. Please notify me in case of illness or emergency.

Presentations: Presentations are required. Presentation dates will be assigned. The presentation reports will also be handed in two weeks after the presentation.

Portfolio: Each group should prepare a portfolio in which all your activities and other group activities will be kept.

Grading

1. Participation and Attendance: 10%
2. Presentations: 5%
3. Project Report: 20% (10 August, 2005)
4. Midterm Exam: 30%
5. Final Exam: 35%
6. Portfolio: 5% (10 August, 2005)

Topics

1. First Meeting. Information about the course; Video
2. Factors Influence how we teach. Being an effective teacher.
   Personal reflections on being an effective teacher.
   Communicating about lessons: Planning, goals, and objectives
3. Cooperative Learning
4. Questioning /Discussion
5. Direct Instruction Strategies/Demonstration /Mathematics Laboratory
6. Drama
7. Discovery Learning/Inquiry
8. Problem-Solving
9. Problem Based Instruction/Project Based Learning
10. Concept Mapping

References:

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Anderson, L.W. (1989). *The Effective Teacher*, USA: McGraw-Hill, Inc. (LB1025.2 A6955)

Arends, R.I. (1998). *Learning to Teach*. Boston: McGraw Hill (LB1025.2 .A773)

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Bell, A. (Ed.)(1997). *Matematik Ogretimi (Ortaogretim)*. YOK/Dunya Bankasi Milli Egitimi Gelistirme Projesi: Hizmetoncesi Ogretmen Egitimi.

Brock, P.A. (1994). *Educational Technology in the Classroom*. Englewood Cliffs, NJ: Educational Technology Publications, Inc.

Busbridge, J. & Ozcelik, D.A. (1997). *Ilkogretim Matematik Ogretimi*. Ankara: YOK/Dunya Bankasi Milli Egitimi Gelistirme Projesi: Hizmetoncesi Ogretmen Egitimi.

Carin, A. A.and Sund, R.B. (1980). *Teaching Modern Science*. Columbus, Ohio: Charles E. Merrill Pub. Co. (LB1585 C27)

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Colletti, A.B. (1987). *Teaching Methods and Applied Techniques*, USA: Keystone Publications, Inc. (LB1025.2 C38)

Cooney, T.J., Davis, E.J. & Henderson, K.B. (1975). *Dynamics of Teaching Secondary School Mathematics*. Atlanta, GA: Houghton Mifflin.

Cooper, J.M. (1994). *Classroom Teaching Skills*. Toronto, D.C: Heath and Company. (LB1025.3 C57)

Cruicksahnk, D.R. (1995). *The Act of Teaching*. New York: McGraw-Hill.

Dembo, M. H. (1988). *Applying Educational Psychology in the Classroom*. New York: Longman (LB1051 D37).

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Froleich, G.W. (Ed.)(1995). *Connecting Mathematics*. Reston, VA.: NCTM, Inc.

Gilbert, H. (1950). *The Art of Teaching*. (LB1025 H63)

Hirsch, C.R. & Laing, R.A. (Eds.) (1993). *Activities for Learning and Teaching*. Reston, VA.: NCTM, Inc.

Hirsch, C.R. (Ed.) (1992). *Data Analysis and Statistics*. Reston, VA.: NCTM, Inc.

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ELE 420 Practice Teaching in Elementary Education

Course Description

Field experience and teaching practice including class observation, adaptation to classroom condition, planning and preparation for teaching. Guided teaching practice in science in elementary schools.

Course Objectives

Practice teaching is a means of providing opportunities for student teachers, under typical conditions in selected cooperating schools, to obtain experience in observing and participating actively in all the diverse educational activities in the school.

At the end of the course students should be able to:

- Demonstrate knowledge regarding different techniques of teaching mathematics.
- Develop and implement mathematics lessons for the elementary school students and be familiar with classroom management techniques.
- Select and use appropriate instructional strategies and equipment.
- Design and implement activities which promote the development of concepts and problem solving skills in mathematics, as well as promote positive attitude toward mathematics.
- Understand how elementary school students learn mathematics.
- Be aware of specific mathematics topics taught in each of the grades 6-8 and know where to gather resources to aid in the teaching of those topics.
- Be familiar with how to assess progress of elementary school students who are learning mathematics and be able to adjust instruction for students with special needs.
- Use different technological tools to develop elementary school students' understanding of mathematics concepts.

Online Components

Online components of this course can be accessed from the following address:

https://online.metu.edu.tr/

Log in using your METU Id and passwords. Please do not forget to update your profiles (esp. your e-mail addresses).

Required Texts:

None required.

Academic Ethics:

All assignments you hand in should be the result of your effort only. Academic dishonesty, including any form of **cheating** and **plagiarism** will not be tolerated and will result in failure of the course and/or formal disciplinary proceedings usually resulting in **suspension** or **dismissal**. Cheating includes but is not limited to such acts as; offering or receiving unpermitted assistance in the exams, using any type of unauthorized written material during the exams, handing in any part or all of someone else's work as your own, copying from the Internet. Plagiarism is a specific form of cheating. It means using someone else's work without giving credit. Plagiarism is a literary theft. Therefore, you have to acknowledge the sources you use in your assignments.

Course Requirements

Attendance: Full attendance is expected to all required classroom visits. The purpose for field experience is to give you an opportunity to observe and reflect upon teaching. Successful completion of ELE 420 includes completing a minimum of 4 hours of classroom observation/participation per week.

Lesson Plans: You will prepare lesson plans for 4 different teaching practices you will conduct. A lesson plan format will be introduced to you during semester.

Campus Lesson: You are required to conduct one lesson in Campus sessions. For this lesson you are expected to submit a *lesson plan* and a *self-critique* paper.

Teaching in School: You are required to plan, implement and reflect on two lessons in school. Only one of these lessons will be observed and assessed by your instructor. For each lesson, you are expected to prepare *lesson plans* and write a *self-critique* about your teaching. These lessons should involve learning activities based on "active learning."

Self Critique Paper: For each of the lesson you conduct, you will write a self-critique that will describe your opinions about your teaching performance. Self critique should be submitted in electronic form through METU-Online (2 pages double spaced).

Self Improvement Paper: I expect you to identify a problem you want to solve in your own teaching behaviors. Then, prepare a document that explains your plan about your self improvement on this problem. Your self improvement paper should include a clear *description* of the problem that you identified. Then include an *analysis* of this problem. I expect you to read literature related to this problem. Then write a plan of self-improvement for this problem by citing suitable references. (4 pages double spaced)
Your Teaching Philosophy: You are required to write a paper about your teaching philosophy. Based on your previous experiences, you are expected to describe your understanding of a "good teacher" and "good teaching." As you already know, the teaching phenomenon has various dimensions. In this assignment I expect you to comment about three basic dimensions: (a) classroom management, (b) interaction with students, and (c) teaching of mathematics. You should explain your own opinions and what you write should reflect your personal teaching philosophy (the teacher that you want to be). (4 pages double spaced)
Discussion Forum Participation: I expect you to participate in an online Discussion Forum at (online.metu.edu.tr). The discussion topics may be based on your observations in the schools. Your participation in discussion forums will be assessed based on the following criteria. The assessment will be done 4 times during the semester.

- Write substantive posts and present new ideas on a regular basis.
- Read others' postings and make comment about them or respond on them (Interact with a variety of participants.)
- You should present your own ideas.
- Your writings should be clear and free of mechanical errors (complete sentences, well organized, grammatically correct, and free of spelling errors)

Grading

Activity	*Percent*
Three Lesson Plans	15
Teaching in School	20
Campus Teaching	15
Three *Self Critique* Papers	15
Self Improvement Paper	15
Discussion Forum Participation	5
Your Teaching Philosophy	15

ELE 443 Methods of Mathematics Teaching

Course Description: Misconceptions/errors in selected mathematical concepts; Teaching these concepts by emphasizing on active learning.

Course Objectives: At the end of the semester, students should be able to
To understand how to use computers and calculators in mathematics course.
To teach mathematics by using computers and calculators.
To understand the misconceptions on mathematical concepts in Numbers/ Algebra/ Geometry/ Probability/Statistics.
To understand the errors on mathematical concepts in Numbers/ Algebra/ Geometry / Probability/Statistics.
To apply the teaching methods to teach Numbers/ Algebra/ Geometry / Probability/Statistics.
To evaluate the effectiveness of their own teaching /their classmates teaching.
To be self-confident in teaching mathematics
To have positive attitude toward teaching mathematics.

Grading:

% 30 Midterm	% 15 Group Presentation/ Group Project	% 35 Final
% 10 Attendance and Participation	%10 Poster	% 5 Portfolio

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Books:

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Thesis:

Bulut, S. (1994). *The Effects of Different Teaching Methods and Gender on Probability Achievement and Attitudes Toward Probability*", Unpublished Ph.D. Thesis, Middle East Technical University, Ankara, Turkey.

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Journals:

- Arithmetic Teacher
- Educational Studies in Mathematics
- Educational Technology
- International Journal of Mathematics Education in Science and Technology
- Journal of Computers in Mathematics and Science Teaching
- Journal of Educational Psychology
- Journal of Experimental Education
- Journal for Research in Mathematics Education
- Journal of Mathematical Behavior
- Mathematics Teacher
- School Science and Mathematics

Content Outline

1. Review the teaching methods (i.e. Cooperative learning, questioning, discussion, discovery learning & problem solving methods). Use of Calculators and Computer Applications in Mathematics Education Watching Video Cassettes on Teaching Mathematics (1.-2 Weeks)

2. Teaching of Mathematics, Misconceptions/Errors on Selected Mathematical Concepts (3.-14. Weeks)

3.1. Numbers (3. - 5. Weeks)
3.2. Algebra (6.-7. Weeks)
3.3. Geometry (8.-10. Weeks)
3.4. Probability (11.-13. Weeks)
3.5. Statistics (14. Week)
4. Poster Presentation

Project:

The project will be on teaching of given subjects. It should cover the followings:

- Content
- Objectives
- Prerequisite knowledge/skills
- Terminology
- Historical background
- Misconceptions
- Real life, occupations, other sciences
- Teaching of mathematical concepts, by using games/puzzles, text, activity/worksheets, materials and by giving directions to teachers to use this teaching materials (Each group member should develop 3 activity sheets)

APPENDIX C

INTERVIEW PROTOCOLS OF THE STUDY

2004 Interview Protocol for Preservice Teachers

Hi,

I am Cigdem Haser, and I am a doctoral student in Department of Teacher Education at Michigan State University in U.S.. I am conducting a study about preservice teachers' perceptions of mathematical understanding and various factors that affect their perceptions. This interview that you volunteered is about my study. Having been volunteered is not a strict condition, and you can quit the interview at any time you want to.

The questions that I am going to ask you are not a part of your program. The answers that you provide will not be shared by any program member, and will not have an impact on your course grade. I will be the only person who has the access to the answers that you presented. In case of using your answer in any publication, I will not mention your name. However, I may use the demographic data that you provided in the instruments that you answered before.

There are 29 main questions in this interview and there are no true answers to the questions that I am going to ask. I am definitely interested in your own ideas and feelings about issues in mathematical understanding and mathematics teaching and learning. Thus, I don't want you to feel stressed about answering my questions.

I want to audiotape our interview if you allow me. If you do not want this interview to be audiotaped, please feel free to express. If you want any part of the interview to be audiotaped, please feel free to express. I respect your privacy and I will turn off the recorder. Although I informed you about this before (in our e-mail or phone communication), I just want to be sure if you know that this interview is likely take one to two hours. Have you organized your time for this interview?

Are there any questions that you want me to answer about the interview before we start? Can we start now? Please tell me if you need a break at any time of the interview.

Thank you.

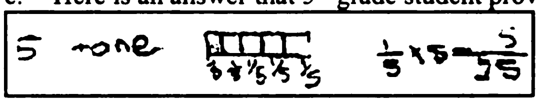
Interview Questions

Nature of Mathematics

1. What is mathematics for?
2. What does it mean to know mathematics?
3. What does it mean to learn mathematics?
    - How is mathematics learned?
    - How did you learn mathematics?
    - How do you think a student should study mathematics in order to learn it?
4. Can you tell me what a "mathematical concept" is depending on your own ideas?
    - What is a "mathematical concept" for you?
    - Can you given an example of a question that asks a "mathematical concept"?
5. How do you know that a student has understood a mathematical concept?
6. Can you tell me what a "mathematical procedure" is depending on your own ideas?
    - What is a "mathematical procedure" for you?
    - Can you given an example of a question that asks a "mathematical procedure"?
7. How do you know that a student has understood a mathematical procedure?
8. Can you tell me what a "mathematical problem" is depending on your own ideas?
    - What is a "mathematical problem" for you?
    - Can you give an example of a "mathematical problem"?
9. How do you know that a student has understood a mathematical problem?
10. Can you describe me "mathematical understanding" depending on your own ideas?
    - What is a "mathematical understanding" for you?

- How did you / Did you develop your own "mathematical understanding"?

11. How do you know that a student has developed a mathematical understanding?
12. Now, I want to learn more about your ideas on a specific task. Here is a question about fractions: "How many $\frac{1}{5}$ s are there in 5?"
    a. Can you solve the question and explain me how you solved it?
        i. Can you show me the parts of your solution related to your conceptual understanding and procedural understanding? (Remind him/her his/her previous answers about understandings.)
    b. How would a 5^{th} grade student solve this problem correctly?
        i. Can you show me parts of this solution related to your views about conceptual understanding and procedural understanding? (Remind him/her his/her previous answers about understandings.)
    c. Here is an answer that 5^{th} grade student provided.



        i. What might he/she have thought while answering this question in this way?
        ii. What might be missing in his/her conceptual understanding?
        iii. What might be missing in his/her procedural understanding?
        iv. What could you do in order to cover those missing points in his/her understanding?

Teaching Mathematics

13. Why do we teach mathematics?
14. What are the types of knowledge that a mathematics teacher should have?
    - Can you make a list of / categorize the types of knowledge that a mathematics teacher should have?

    a. Why do you think that a mathematics teacher should have these types of knowledge?
15. What will be your main purpose in teaching mathematics in the future?
    - Students' understanding, learning, enjoyment, attitude, or the concept itself as a focus.
16. Do you have any teaching experience? In which ways and for how long?
17. What are your strengths in teaching mathematics?
18. What are your weaknesses in teaching mathematics?
19. Which mathematical concepts do you like/not like to teach?
    a. Why do you like/ do not like these concepts?

Attitudes towards Mathematics and Teaching and Learning Mathematics

20. Do you enjoy learning mathematics? When? Why?
21. Do you enjoy teaching mathematics? When? Why?
22. In general, do you enjoy dealing with mathematics? When? Why?
23. Do you think that enjoyment is important in teaching and learning mathematics? When? Why?

Policies

24. Do you think that your high school education was effective in the way you study mathematics? How?
    a. Is there a specific mathematics teacher that affected your ideas about mathematics?
    b. How did you study math during high school?
25. Do you think that university entrance examination affected your way of studying mathematics? How?
26. How would the previous system affect your way of studying mathematics if you were to take the new exam? Why?
27. Do you think that the courses you have taken in this program are useful for your profession? Why?
    a. What are the courses that you would like to have?
    b. What are your expectations from the professors in your program during the courses?
    c. Do you think that the courses would be different if you had another instructor?
28. What kind of knowledge and skills should a mathematics teacher educator have?
    a. What kind of expectations should he have from the preservice teachers?

Other Questions

29. How can you define teaching as a profession?
    a. What does a teacher do?
    b. What does a mathematics teacher do?
30. Do you think that the knowledge and skills you gained in the program will be sufficient for your teaching?
    a. What can a teacher do to improve his/her knowledge and skills?
    - What are the sources of knowledge for a teacher to improve his/her knowledge and skills?
    - Do you think a teacher can learn from his/her students? How?
31. How would you define teaching as a profession before you started studying in this program?
    a. How have your ideas changed about teaching profession?
32. What would you want me to ask in this interview, that I did not ask you?
    a. Why is this question important to you?
    b. Would you answer it if I ask now?

2003 Interview Protocol for the Graduates

Hi,

I am Cigdem Haser, and I am a doctoral student in Department of Teacher Education at Michigan State University in U.S. I am conducting a study about prospective teachers' perceptions of mathematical understanding and various factors that affect their perceptions. This interview that you volunteered is about my study. Having been volunteered is not a strict condition, and you can quit the interview at any time you want to.

The questions that I am going to ask you are not a part of your program. The answers that you provide will not be shared by any program member, and will not have an impact on your course grade. I will be the only person who has the access to the answers that you presented. In case of using your answer in any publication, I will not mention your name. However, I may use the demographic data that you provided in the instruments that you answered before.

There are 23 main questions in this interview and there are no true answers to the questions that I am going to ask. I am definitely interested in your own ideas and feelings about issues in mathematical understanding and mathematics teaching and learning. Thus, I don't want you to feel stressed about answering my questions.

I want to audiotape our interview if you allow me. If you do not want this interview to be audiotaped, please feel free to express. If you want any part of the interview to be audiotaped, please feel free to express. I respect your privacy and I will turn off the recorder. Although I informed you about this before (in our e-mail or phone communication), I just want to be sure if you know that this interview is likely take one to two hours. Have you organized your time for this interview?

Are there any questions that you want me to answer about the interview before we start? Can we start now? Please tell me if you need a break at any time of the interview.

Thank you.

Interview Questions

Nature of Mathematics

1. What is mathematics for?
2. What does it mean to know mathematics?
3. Can you tell me what a "mathematical concept" is depending on your own ideas?
   - What is a "mathematical concept" for you?
4. How do you know that a student has understood a mathematical concept?
5. Can you tell me what a "mathematical procedure" is depending on your own ideas?
   - (What is a "mathematical procedure" for you?)
6. How do you know that a student has understood a mathematical procedure?
7. Can you tell me what a "mathematical problem" is depending on your own ideas?
   - What is a "mathematical problem" for you?
8. How do you know that a student has understood a mathematical problem?
9. Can you describe me "mathematical understanding" depending on your own ideas?
   - What is a "mathematical understanding" for you?
   - How did you / Did you develop your own "mathematical understanding"?
10. How do you know that a student has developed a mathematical understanding?

Teaching Mathematics

11. Why do we teach mathematics?
12. What are the types of knowledge that a mathematics teacher should have?
    - Can you make a list of / categorize the types of knowledge that a mathematics teacher should have?
    a. Why do you think that a mathematics teacher should have these types of knowledge?
13. What will be your main purpose in teaching mathematics in the future?)
    - Students' understanding, learning, enjoyment, attitude, or the concept itself as a focus.
14. What are your strengths in teaching mathematics?
15. What are your weaknesses in teaching mathematics?

Attitudes towards Mathematics and Teaching and Learning Mathematics

16. Do you enjoy learning mathematics? When? Why?
17. Do you enjoy teaching mathematics? When? Why?

18. In general, do you enjoy dealing with mathematics? When? Why?
19. Do you think that enjoyment is important in teaching and learning mathematics? When? Why?

Policies

20. Do you think that university entrance examination affected your way of studying mathematics? How?
21. How would the new system affect your way of studying mathematics if you were to take the new exam? Why?
22. Do you think that the courses you have taken in this program are useful for your profession? Why?
    a. What are the courses that you would like to have?
    b. Do you think that the courses would be different if you had another instructor?
23. What would you want me to ask in this interview, that I did not ask you?
    a. Why is this question important to you?
    b. Would you answer it if I ask now?

2004 Interview Protocol for First-Year Teachers

Hi,

I am Cigdem Haser, and I am a doctoral student in Department of Teacher Education at Michigan State University in U.S.. I am conducting a study about inservice teachers' perceptions of mathematical understanding and various factors that affect their perceptions. This interview that you volunteered is about my study. Having been volunteered is not a strict condition, and you can quit the interview at any time you want to.

The questions that I am going to ask you are not a part of your program. The answers that you provide will not be shared by any member of the school that you are teaching and will not have an impact on your reappointment. I will be the only person who has the access to the answers that you presented. In case of using your answer in any publication, I will not mention your name. However, I may use the demographic data that you provided in the instruments that you answered before.

There are 35 main questions in this interview and there are no true answers to the questions that I am going to ask. I am definitely interested in your own ideas and feelings about issues in mathematical understanding and mathematics teaching and learning. Thus, I don't want you to feel stressed about answering my questions.

I want to audiotape our interview if you allow me. If you do not want this interview to be audiotaped, please feel free to express. If you want any part of the interview to be audiotaped, please feel free to express. I respect your privacy and I will turn off the recorder. Although I informed you about this before (in our e-mail or phone communication), I just want to be sure if you know that this interview is likely take one to two hours. Have you organized your time for this interview?

Are there any questions that you want me to answer about the interview before we start? Can we start now? Please tell me if you need a break at any time of the interview.

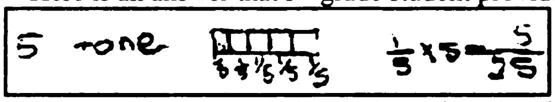
Thank you.

Interview Questions

Nature of Mathematics

1. What is mathematics for?
2. What does it mean to know mathematics?
3. What does it mean to learn mathematics?
   - How is mathematics learned?
   - How did you learn mathematics?
   - How do you think a student should study mathematics in order to learn it?
4. Can you tell me what a "mathematical concept" is depending on your own ideas?
   - What is a "mathematical concept" for you?
   - Can you given an example of a question that asks a "mathematical concept"?
5. How do you know that one of your students has understood a mathematical concept?
6. Can you tell me what a "mathematical procedure" is depending on your own ideas?
   - What is a "mathematical procedure" for you?
   - Can you given an example of a question that asks a "mathematical procedure"?
7. How do you know that one of your students has understood a mathematical procedure?
8. Can you tell me what a "mathematical problem" is depending on your own ideas?
   - What is a "mathematical problem" for you?
   - Can you give an example of a "mathematical problem"?
9. How do you know that one of your students has understood a mathematical problem?
10. Can you describe me "mathematical understanding" depending on your own ideas?
    - What is a "mathematical understanding" for you?
    - How did you / Did you develop your own "mathematical understanding"?
11. How do you know that one of your students has developed a mathematical understanding?
12. Now, I want to learn more about your ideas on a specific task. Here is a question about fractions: "How many $\frac{1}{5}$ s are there in 5?"
    - Can you solve the question and explain me how you solved it?

        i. Can you show me the parts of your solution related to your conceptual understanding and procedural understanding? (Remind him/her his/her previous answers about understandings.)
  - How would a 5th grade student solve this problem correctly?
        i. Can you show me parts of this solution related to your views about conceptual understanding and procedural understanding? (Remind him/her his/her previous answers about understandings.)
  - Here is an answer that 5th grade student provided.



        i. What might he/she have thought while answering this question in this way?
        ii. What might be missing in his/her conceptual understanding?
        iii. What might be missing in his/her procedural understanding?
        iv. What could you do in order to cover those missing points in his/her understanding?

13. Do you think that your ideas have changed since you graduated and started teaching? What has affected your ideas?
14. Can you give examples of your lesson plans each of which reflects emphasis on one or more types of understanding that we have talked about?
15. Without mentioning name or any form of student data, can you give examples of three particular students who have rich, medium, and poor mathematical understanding and related student behaviors?
16. Can you plan one or a series of lessons (depending on your preference) on a particular topic which reflects your conceptions of mathematical understanding, without considering other pressures such as material availability and time allowed for that particular topic in the curriculum for one of your classes or a class of 30 students?
17. Can you provide me copies of examples of assessment tasks (written exams, quizzes, oral exams, homework, term projects) that you implement on your students?
    - What kind of understanding do these tasks address?

Teaching Mathematics

18. Why do we teach mathematics?
19. What are the types of knowledge that a mathematics teacher should have?
    - Can you make a list of / categorize the types of knowledge that a mathematics teacher should have?
    - Why do you think that a mathematics teacher should have these types of knowledge?
20. What is your main purpose while teaching mathematics?
    - Students' understanding, learning, enjoyment, attitude, or the concept itself as a focus.
21. Did you have any teaching experience before you started teaching as a formal teacher? In which ways and for how long?
22. Are there any pressures or supports that affect your teaching, such as students, parents, school administrators or curriculum?
    - Do you think that you would teach more effectively if any one or more of these factors had changed? Why and in what ways?
23. Which grades are you teaching now?
    - Which grades would you prefer to teach? Why?
24. What are your strengths in teaching mathematics?
    - Did you ever realize that these are your strengths before you become a formal teacher?
25. What are your weaknesses in teaching mathematics?
    - Did you ever realize that these are your weaknesses before you become a formal teacher?
26. Which mathematical concepts do you like/not like to teach?
    - Why do you like/ do not like these concepts?

Attitudes towards Mathematics and Teaching and Learning Mathematics

27. Do you enjoy learning mathematics? When? Why?
28. Do you enjoy teaching mathematics? When? Why?

29. In general, do you enjoy dealing with mathematics? When? Why?
30. Do you think that enjoyment is important in teaching and learning mathematics? When? Why?

Policies

31. Do you think that the courses you have taken in the program are useful for your profession? Why?
    - What are the courses that you would like to have but not offered in the program?
    - What were your expectations from the professors in your program during the courses?
32. Are you a student in a master's program? Where?
    - Why have you decided to pursue a M.S. degree?
    - Do you think that it will be useful for your profession as a mathematics teacher? If so, in what ways?
33. What kind of knowledge and skills should a mathematics teacher educator have?
    a. What kind of expectations should he have from the preservice teachers?

Other Questions

34. How can you define teaching as a profession?
    - What does a teacher do?
    - What does a mathematics teacher do?
35. How would you define teaching as a profession before you started teaching as a formal teacher?
    - How have your ideas changed about teaching profession?
36. Do you think that a teacher should improve his/her knowledge and skills? Why / Why not?
    - What kinds of knowledge and skills should a teacher improve?
    - What are the ways or sources of information that a teacher can improve his/her knowledge and skills?
    - Do you think a teacher can learn from his/her students? How?
37. What would you want me to ask in this interview, that I did not ask you?
    - Why is this question important to you?
    - Would you answer it if I ask now?

Interview Protocol for Faculty

Hi,

I am Cigdem Haser, and I am a doctoral candidate in Department of Teacher Education at Michigan State University in U.S.. I am conducting a study about prospective teachers' conceptions of mathematical understanding and various factors that affect their conceptions. This interview that you volunteered is about my study. Having been volunteered is not a strict condition, and you can quit the interview at any time you want to.

For this study, I need the ideas of the faculty about the program and about certain characteristics that preservice and inservice mathematics teachers have. The questions that I am going to ask you are generally about these issues. The answers that you provide will not be shared by any program member. I will be the only person who has the access to the answers that you presented. In case of using your answer in any publication, I will not mention your name. However, I may use the demographic data that you provided.

There are 15 main questions in this interview and there are no true answers to the questions that I am going to ask. I am definitely interested in your own ideas about issues in preparation of mathematics teachers and their beliefs. Thus, I don't want you to feel stressed about answering my questions.

I want to audiotape our interview if you allow me. If you do not want this interview to be audiotaped, please feel free to express. If you want any part of the interview to be audiotaped, please feel free to express. I respect your privacy and I will turn off the recorder. Although I informed you about this before (in our e-mail or phone communication), I just want to be sure if you know that this interview is likely take one to two hours. Have you organized your time for this interview?

Are there any questions that you want me to answer about the interview before we start? Can we start now? Please tell me if you need a break at any time of the interview.

Thank you.

Interview Questions

1. How long have you been teaching in the program? / How long have you taught in the program?
2. How long have you been teaching in general?
   - In another program, at a school
3. Which courses did you offer in the program? Could I get a copy of the syllabuses of the courses that you offered?
4. Do you think that program effectively prepares students to be mathematics teachers?
   a. What are the effective experiences/courses in the program?
   b. What are the ineffective experiences/courses in the program?
   c. How would the program be improved?
5. What are your goals in general in teaching a course?
6. Can you describe the characteristics of effective mathematics teachers?
   a. What kind of knowledge should mathematics teachers have in order to teach mathematics effectively?
7. Can you describe the beliefs that a mathematics teacher should have?
   - About nature of mathematics, about teaching and learning mathematics
8. Can you describe the beliefs of younger students in the program about nature of mathematics and teaching and learning of mathematics?
9. Can you describe the beliefs of older students in the program about nature of mathematics and teaching and learning of mathematics?
10. How do you think these beliefs are/can be changed?
11. Do you specifically address/target these beliefs in your teaching? How?
12. Do you see any difference in beliefs about and attitudes towards mathematics and teaching and learning mathematics, and depth of students' work based on the high school experience?
13. Do you see any difference in beliefs about and attitudes towards mathematics and teaching and learning mathematics, and depth of students' work based on the university entrance examination experience?
14. Which courses do you prefer to teach? Why?
15. What do you expect from your students in your courses in general?

APPENDIX D

SAMPLE DATA CODING

Complete Translation of Dina's Interview

Notes:

- [C: (for Cigdem) means that I ask a prompt question.]
- *Italic* words mean that the participant spoke in English.
- [Brackets generally contain my explanations about what the participant is talking about.]
- (Parentheses contain the exact translation of a word, which may not fit the meaning in that context. Another closer meaning is just provided before the parentheses.)
- There is no gender difference in Turkish while one talks about an arbitrary person. So I translated references to an arbitrary person as "he" if Dina did not use female pronouns.

Interview Questions

Nature of Mathematics

1. What is mathematics for?

Mathematics is for making it easy for people to understand the life. I mean, it also makes their lives easier. By enabling people to think comprehensively(widely), it [mathematics] is providing an intellectual view. In this sense, I think it [mathematics] is for enjoying the life.

2. What does it mean to know mathematics?

Knowing mathematics is approaching to the problems that human face in a mathematical way. I mean, it is implementing the solutions by a mathematical view.

[C: What kind of problems are these?]

<u>It can be anything that we face in daily life. Such as calculating the money in a shopping or whether the money will be enough and measuring time (U1).</u> Or, the things that we have difficulty in dealing with such as *calculus* problems that we study at the university level or producing comprehensive theorems. Knowing mathematics does not enable us to solve these problems, but it makes it easier for us to solve these problems.

3. What does it mean to learn mathematics?

Mathematics is actually.. cannot be learned all of a sudden... something that can be learned in a way... <u>It requires too much effort (U1).</u> We are sharing our knowledge(savings) with people first in the elementary level, then in the secondary level, and then at the university, <u>we make people get this [knowledge]. While doing these, we either explain or show, we make them [people] discover these (U2).</u> I mean, people need to know an essential level of mathematics. If they want to put more on this they move towards mathematics and continue to the existing studies themselves in some way.

- How did you learn mathematics?

I... was enjoying mathematics at the high school and I actually did not think of being a mathematics teacher but my father guided(directed) me. He is an elementary school teacher. I actually did not really know the kind of mathematics that I was going to study in the process of being a teacher. How did I learn mathematics? Actually, the mathematics that we will teach and the mathematics that we study here do not overlap that much. But, like every university student, we have to have some qualifications(things). I actually enjoyed the mathematics that I studied here. I think that it enhances one [one's thinking] in terms of perspectives.

I did not study to the concepts that much but I, for example, used to think that I would not be able to understand a problem which I don't know anything about it [the problem]. I am not taking any math courses in the past three semesters and I took a course on geometry as an elective course. <u>In the courses I studied, I realized that when I already mastered the concepts, I gained better practical skills by solving the questions myself. If there appeared anything that I could not understand during the class, I formed the</u>

following system: first studying the concepts, then solving examples, then new solving questions with others, and finally solving the questions and tests at the end of the *chapter* **(U3)**.

4. Can you tell me what a "mathematical concept" is depending on your own ideas?

- What is a "mathematical concept" for you?

For me, it is the case that "that thing" can be explained in the mathematical language. For example, if idiom is a concept in Turkish, then it can only be explained in the Turkish [course]. I think that, that thing, that object, or whatever the thing that requires a solution is.. if that has an equivalent in the mathematical language, then it becomes a *mathematical concept.*

- Can you give an example of a question that asks a "mathematical concept"?

For example... "What is an angle?" Angle is a mathematical concept.

5. How do you know that a student has understood a mathematical concept?

In relation to this concept [angle].. If he can explain it in the *knowledge* level, give examples in the *comprehensive* level [referring to the Bloom's Taxonomy], implement it to the new questions, and also to other things such as other things in his life, then we can say that he learned this [concept].

6. Can you tell me what a "mathematical procedure" is depending on your own ideas?

Mathematical procedure, probably is first understanding the problem, then tracking the data out of this [the problem] and producing a solution, implementing them and then going back [to the beginning] and controlling, and reaching various analysis through these results.

- Can you give an example of a question that asks a "mathematical procedure"?

Worker, pool problems [famous types of problems in middle school level] might be examples for these. "If A can do a work in this many days and B can do the same work in this many days, then in how many days will A and B do the work together?" [can be an example].

7. How do you know that a student has understood a mathematical procedure?

For example, in these question [like the ones above] most of the teachers give formulas in the test preparation centers and [they understand] whether [the students] have understood the question... If there are those words in the question [there are certain expressions in those problems which leads to certain mathematical operations with the given quantities], then they [test preparation center teachers] try to teach the worker-pool problems by formulizing. But the fact that students can use the formula alone does not guarantee (show) that they [the students] have understood this [problem]. If he [the teacher] in some way, can make them [the students] explain, if they [the students] tell the procedures themselves..[such as] there is the given [data], there is the required thing, if we implement this solution we find this, and the solution that we have gives the work that they [A and B, referring to the problem she mentioned in question 6] do together, and if they [the students] explain the results in a logical way, then I think that they have understood **(U1)**.

8. Can you tell me what a "mathematical problem" is depending on your own ideas?

The problem that contains mathematical terms, the problem that [people] use mathematics.

- Can you give an example of a "mathematical problem"?

For example... triangle question.. It can be area question..

9. How do you know that a student has understood a mathematical problem?

Similarly, they [the students] can implement the method in the pervious question [question 7]. They can use these skills(savings) in different questions... They can enhance in some ways.. I mean they can produce different questions..**(U1)**

10. Can you describe me "mathematical understanding" depending on your own ideas?

To approach(look at) to the problems or the things that they [people, in general] face with the eyes of a mathematician or by using mathematics. [Giving an arbitrary example that she generates at that moment] It can be saying "there is a bottle of water", "there is some water", or "there is 0.5 liters of water". Using "0.5" instead of "some" is [an indication of] a mathematical perception or expression for me.

- How did you / Did you develop your own "mathematical understanding?"

Somehow by guidance, by realizing that I somehow enjoy mathematics, and by having chosen this type of college experience [referring to department].. When you find yourself in this track...I mean, mostly since I wanted. It was developed through the courses that I took and by my own effort.

11. How do you know that a student has developed a mathematical understanding?

Students come to schools with a certain level [of intelligence/skills/knowledge] and they are implemented certain measurement and evaluation processes [in the process of reaching a level]. These could be observations or scales/tests. If there appears a positive improvement when they [the students] are implemented these [evaluation processes], then we can say that there is an improvement. Or if he can express that, I mean the thing that he understood (U1)...[and] if you can observe this [expressing his own understanding] improvement. Or if he can implement this point of view to the things that he faces...

12. Now, I want to learn more about your ideas on a specific task. Here is a question about fractions:

"How many $\frac{1}{5}$ s are there in 5?"

a. Can you solve the question and explain me how you solved it?

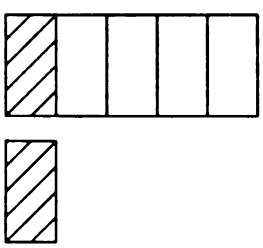
I divide 5 by 1/5. 5 times 5 is 25. Here, [we find] how many times does 5 have 1/5 by division..

i. Can you show me the parts of your solution related to your conceptual understanding and procedural understanding?

For example... in terms of concept, there is division... in terms of procedure...First, what does it ask after understanding the problem... Just a second.. and in terms of procedure... we have, for example... We use multiplication at the same time.. I wonder which concept does "how many 1/5 s are there in 5" associate with... Just a second.. I thought about division, but... yes, there is division, the concept of division.

b. How would a 5th grade student solve this problem correctly?

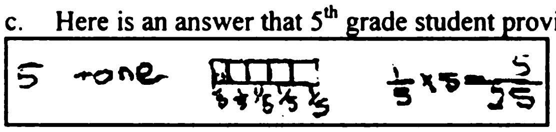
I think, first, he can do.. within 1..



For instance, this is a whole [the figure on the top]. And this is the piece that shows 1/5 [the figure on the bottom]. He will think that a whole includes 5 small boxes. In this case for 5, if this is 1 whole, we need 5 of this [1 whole]. Hence, how many are there in 5 wholes? He can think like.. how many... he can solve it by [using] proportion:

1 whole   5 many
5 wholes   x many

c. Here is an answer that 5th grade student provided.



i. What might he/she have thought while answering this question in this way?

I think he knows multiplication concept and division concept, but maybe.. For example, when it is 5... he considered that there are 5 many of this [1/5] here [in 1, referring to the figure the student drew]. But he could not think that he has to write 5 instead of 1/5 here [the multiplication the student did].

ii. What might be missing in his/her conceptual understanding?

iii. What might be missing in his/her procedural understanding?

iv. What could you do in order to cover those missing points in his/her understanding?

I think.. the student here.. expressed that there is 1/5 in 1 whole nicely. But, for instance, he did not think much about 5 things side by side. We can make him explain this again. I mean, after this operation [multiplication], at the moment ask about "there are 5 many 1/5's in 1", he will say "a-ha!" I mean, I thought that there is something missing there. When I take a look at here [the figure], it is great, yes he can do correctly after this, but why did he take 1/5 here [into the multiplication]? If we express this to him.. if he took 1/5 instead of taking 5.. there is nothing that can be recovered... I mean, I would probably teach in this way. By asking him to explain and by asking him questions about the issues that he is missing some points, I will be able to make him think deeply. Or, if he cannot understand this in this way, then I might give daily life examples, such as, 5.. oh, we could use small boxes, as well. How many small boxes of 1/5 [the small boxes that represent 1/5] in the boxes of 5…or I might be able to express this by a balance scale in some way. How many 1/5 should I put [on one side of the weight scale] so that this side will be equal to the 5 on the other side (U1). This might be… I mean… kilogram measurement and gram measurement.. I mean the numbers..

Teaching Mathematics

13. Why do we teach mathematics?

[For making] people view life much easier, [for making] them view things they face somehow with the mathematical way.. I mean, not all people know mathematics, but they can live. Actually, people do not need to know mathematics, university level mathematics, to continue their lives. But this [knowing mathematics] opens up people's perceptions and opens up the innovations that can change the world. And we use them, eventually. We need mathematics for the advancement of humanity and we teach it for this reason.

14. What are the types of knowledge that a mathematics teacher should have?

First of all, content knowledge-mathematics knowledge is needed. Then, there is a need for educational knowledge, I mean pedagogical knowledge. Pedagogy includes [knowledge ranging from] classroom management, [to] understanding students, [to] guiding them, and [to] motivating them. Knowledge of education and being a friend.. becomes.. too interrelated.. I mean, students should see their mathematics teacher be close to them so that they enjoy mathematics. We have to make them feel that we are close to them, too. Actually, all teachers should have an admirable personality [character]. He has to be consistent. He should not make mathematics perceived as a class, he has to make students feel that mathematics is used in every stage of life. As an example, in one of the schools that I did my student teaching, the teacher was not only teaching mathematics. In an article that he brought to the class, there was something that was about mathematics. He was cutting it [that article, referring to a newspaper article], bringing it to the class, and reading it to the students. He was both making students say "There is math in other fields" and making them motivated.

[C: Can you put them in an order of importance?]

Content area knowledge.. It is too much for teaching mathematics to the elementary school students. I mean, we don't even teach the amount [of mathematical knowledge] that we know. We know both calculus and linear [algebra], but we don't teach them. But having the ability(specialty) to teach them is so important for me, [such as] to reach [down] to the level of the students, to present them different examples… A person might know mathematics really good but he might not be able to develop methods to teach it, there also a need for this kind of intelligence: "Where should I use what [kind of knowledge] so that students will understand better?" .. I think these two [content knowledge and knowledge of how to teach (pck)] are equal [in terms of importance]. A teacher should not cause misconceptions as well… but not that much critical [in terms of importance], as I said.. I see them all equal [in terms of importance].

a. Why do you think that a mathematics teacher should have these types of knowledge?

The fact that one is a teacher requires these, I think. Teaching is not only transferring what you know, but it is transferring what you know in the best way (U1). I mean, transferring in a way that the students can progress further. I mean, we don't only teach 5 times 5 makes 25 to the kids. Moreover, there is a need give them the enjoyment of learning it [mathematics]. The person who will enable them to learn it regularly (orderly), to learn it more is the teacher. In this sense, there is a need for educational knowledge and knowledge of methods, besides the content knowledge. Besides these, we don't only do instruction at schools. Education and instruction go together. In order to have people with healthy development [in terms of growing up], they have to get different things. We have to help them in this development as well. In this sense, we have to do other things like.. being a friend and providing motivation..

15. What will be your main purpose in teaching mathematics in the future?)

Actually, I haven't generated a way to go through yet, such as "this is my goal, this is my principle." But it won't be only transferring the curriculum. In any way.. eventually.. there are things that a student who completed the 5th grade. One of the jobs of the teacher is to make the students comprehend these things, for sure (U1). But it is to make them enjoy mathematics, to have positive ideas towards mathematics, and to make them curious, make them approach life with a mathematical viewpoint. To make them enjoy mathematics, though it is still… in so many schools and… although there are too many tools related to mathematics that are in use, it is still the course that so many students are afraid of. To make them overcome this fear, to tell them that mathematics is more than being a course, it is a perspective that you have to view life.

16. Do you have any teaching experience? In which ways and for how long?

I tutored few students, for not so long, about a month. All of them were in the elementary level. I worked in a test preparation center for about a month. (She also taught to lower SES students in a student club organization for sometime.)

17. What are your strengths in teaching mathematics?

18. What are your weaknesses in teaching mathematics?

Actually, I think that my content knowledge is sufficient, but I have to put more effort in the motivation issue, on providing students with motivation. I enjoy teaching them something but at the same time, for example, it is a little difficult task to motivate all students. While making one of them involved in the class, you can ignore the others. I experienced this [situation] once during the student teaching. When that happens, it [teaching] does not reach its goal. It is something that improves through experience. It is so important to have that kind of openness. And one more thing, when you teach for the first time you focus on only one part. Because you are so anxious, you think about the thing that you will teach immediately after what you are teaching at that moment: "Am I teaching properly, maybe I have to do this there.." In general course [you can ignore this]... This might be my insufficiency. For example, I think that I comfortably be friend with the students, I actually do not treat students like I am an adult. But, as I told you, the point that I am insufficient is the ability to do things that will increase all students'(students as a class) motivation. I think I can improve this.

19. Which mathematical concepts do you like/not like to teach?

a. Why do you like/ do not like these concepts?

I enjoy geometry a lot. I used to solve the geometry questions with enjoyment when the students asked them the test preparation center [where she worked for a month]. I mean, I used to teach those as well. But besides this, I realized during my student teaching that I teach the classes that includes materials with a lot of enjoyment, too. Actually, I don't discriminate but teaching a little more abstract classes are likely to be difficult. For this reason, I enjoy more the classes that student enjoy material use.. I mean, the classes that I realize that they understand (U1).

In terms of concepts.. Actually, it changes from students to students, it also changes from the age group to age group. For example, the [concept] that I like the most.. angles.. binomials is also a nice concept. But when the students don't understand... you get bored, too. For this reason, I like the classes that students understand.

Attitudes towards Mathematics and Teaching and Learning Mathematics

20. Do you enjoy learning mathematics? When? Why?

21. Do you enjoy teaching mathematics? When? Why?

Yes, I enjoy. For example, it can also be a bad thing, but not sitting down by myself and not wondering about a theorem in somewhere, not saying that I have to know that and not studying that [theorem] is a bad thing. But, I don't do this [studying theorems] too much. But, I am making it up, for example, I learn something new while reading Science and Technology [a monthly, more than a popular science journal published by Turkish Scientific and Technical Research Institution, a governmental research institution]: Something mathematical, something about mathematics, or something about the mathematicians... I enjoy it a lot. Or I have a roommate. She prepares activities, she finds a new method, and she shares this with me. We say "Yes, we can teach this in this way to the students, this is a great method, we can develop this kind of materials." I like these kind of things.

I enjoy mathematics both at the time that I am learning about how to teach math and when I learn about a method. [I enjoy] When I learn something new: something about the history of mathematics, it ca be a new problem, a puzzle... in Science and Technology [same journal] or in Intelligence Games [another journal].. things like these.

22. In general, do you enjoy dealing with mathematics? When? Why?

Yes .

23. Do you think that enjoyment is important in teaching and learning mathematics? When? Why?

For me, it is important. Your facial expression is so important. I mean, it is because, when you say "ufff!!" [an interjection that is generally used to show that you got really really bored.] [while teaching], the person right across you would not enjoy that, too. Same is also [valid] for us. When we were students and when the teachers were not smiling and were bored, we weren't enjoying [the class] either. Hence, if we get their motivation and shine, then we can teach the things that we enjoy, we can make students enjoy it. For this reason, it is really important to enjoy mathematics. For this reason, it is different to love mathematics than to enjoy mathematics.

[C: What is the difference?]

A person studies only for mathematics. But not all mathematics teachers are like this. But I think, all mathematicians and the people who are dealing with mathematics enjoy mathematics. It is about enjoying mathematics. But the love of mathematics is something different. It would be much better if we love mathematics.

Policies

24. Do you think that your high school education was effective in the way you study mathematics? How?

[She studied in a science high school.] Actually, we did not do many things at the 3rd grade [last year of high school]. If we think about the recent educational system [the situation that curriculum of 3rd grade does not appear in the university entrance exam]… But in the 2nd and 1st grade, for example in the geometry classes, the teacher used to write a theorem and used to ask us to prove that. Easy theorems, like "if something happens, then something happens", as we know, about triangles, for example, bisector theorem. He used to tell us to prove that. He did not teach the class like: "This is this, and this is this. Memorize these to solve the questions." Since he did not teach in that way, we used to struggle with it [the theorem], and we used to enjoy that (U1). In the following class we solved those [questions]. This [way of teaching/learning] helped me to enjoy mathematics more. And, since I did not memorize, I did not feel difficulty later (U2). I enjoy geometry for this reason… I enjoyed by this way..

a. Is there a specific mathematics teacher that affected your ideas about mathematics?

I actually liked my physics teacher. But mathematics teachers were not the teachers that you don't like.

b. How did you study math during high school?

We were learning mathematics in the class. Since it was not that much a memorization class, I mean since there was no memorization of formula and since they [the teachers] taught us until we answered "Has everyone understood?.... Yes, understood", we did not need to study a lot (U3). We generally used to solve more difficult problems in the classes compared to the examinations, hence there was no need to study too much for the exams, I mean going to the class prepared was more important.

25. Do you think that university entrance examination affected your way of studying mathematics? How?

Actually.. in the 3rd grade.. It requires a surface level of studying more than it requires the [studying] essence of the concept. Thus, there is a need to solve a lot of questions in order to improve practical [skills]. I used to like it sometimes, but I got bored sometimes, too. I enjoy studying the concept slowly in the beginning and then solving questions about it more. My system of studying was in this way. But I realized in the 3rd grade that, if I study in this way, I would not be able to cover all the concepts. Hence, I started to solve more questions. For example, although I did not understand some parts of the probability concept, I scanned these roughly (surface level), by solving questions. In this sense, I don't think that studying for university exam is an educative study.

26. How would the previous system affect your way of studying mathematics if you were to take the new exam? Why?

It would probably be changed. Because people who took that exam used to say that it measured more about whether you have understood the concepts or not, they used to say that the content of the questions were in that way. For this reason, it would probably be changed.

[C: Would you be continuing with your way of studying?]

Yes, it would probably be in that way.

27. Do you think that the courses you have taken in this program are useful for your profession? Why?

(about math courses:) Math courses are not one-to-one [useful for my profession]. We are not teaching derivative and integral, or matrix and determinant. However, I think that the 111 and 112 courses [courses about abstract mathematics] that we took in the first year will be useful in [teaching] the concept of probability. But actually the university education that we have been through is something like that. To improve people's perspective and it is a step [for people] to improve themselves.. I mean, if we do master's and doctoral degree, then maybe we will learn something in the name of improvement. I don't think that we are learning to implement one-to-one.

(about the educational courses:) But, for example, the educational courses I took serve for this purpose. For example, we take methods course. I think they [the courses from the department] will be useful. It is not that I don't think the others [math courses] will be useful.. they just do not reflect one-to-one [match]. The educational courses that we take here [in the college of education] are the courses that we can see equivalent in our classrooms. I will be able to use the things that I presented or the materials that I used in the methods courses that I took this year or last year. Or as in the case of guidance class, the methods I studied(saw) there are the things that I said "OK., I will behave in this way now" when I had to deal with problem students [referring to her student teaching].

a. What are the courses that you would like to have?

There were classes that our professors thought about offering, but they could offer not since there were not enough students. I would like to take a class.. about geometrical concepts.. how we teach them.. For example, there is a course that is offered in this semester but I could not take, sketchpad.. I would like to take that course, too. I think there is a course [about] making mathematical materials. I think this course could be offered as a must course, not as an elective course. Actually, in general, there are [courses] offered. There have been more courses offered in the past few years.

b. What are your expectations from the professors in your program during the courses?

Teaching that class in a good way. The classes that I am not going to say "uffff!" [an expression of getting bored, or doing something unwanted at]. To teach me things that will be useful when I become a teacher or during my university life. It is not only the things they teach but it can be anything in general... to teach something, really... Not to present the course alone, to make us contribute... to leave a question mark in our minds(us).. In the first years, we used to complain a lot, they were giving us too many assignments. But we realized that we were able to do many things by doing assignments. We would not be able to gain many things if there were not any assignments. There were no assignments, no other things, but we were made to present things in some of the courses. I learned less from these.

c. Do you think that the courses would be different if you had another instructor?

Yes. The second methods course. Since there is not so many professors, I cannot compare. But while taking the second methods course, I said I wish we took that class from the professor who offered the first one [methods course].

28. What kind of knowledge and skills should a mathematics teacher educator have?

First of all he should have great knowledge and skills. For example.. I am making up [the situation] now, we will be teaching in public schools and we won't be able to use many things [that we learned here]. For example, *instruction with media* course was not necessary for us, I am making it up. But a mathematics [teacher] educator should know these. He has to know the current, updated things. He has to know a lot about the field. I think that he has to know a lot about theoretical things at the same time, not only the practical (in use) things.

a. What kind of expectations should he have from the preservice teachers?

From us, for instance.. while writing an essay, our professor once told us, "This [the essay] should be in the way of a scientific paper." He did not say it in the 1st year but in the 4th year. He did not have such an expectation in the 1st year. Because we were still busy with watching the remainders of our high school education in the 1st year. The expectations change eventually every semester. But by now, this is a person who can be a teacher, I mean, the expectation of having the *qualifications* [of a teacher]. [The student] reaches to that at the end. Something good.

For instance, in my 1st year, I would not be able to do the things that I can do in the 4th year. But the situation that these are not expected.. I mean it would be a bad thing to expect less in the 4th year. I will be a teacher in a year or a few months later. Actually the expectations are the things that improve me. For this reason, these should be higher so that I can improve.

Other Questions

29. How can you define teaching as a profession?

a. What does a teacher do?

The teacher teaches. Teachers, in some way... knowledge alone... knowledge.. how can I express?.. like digestible wholes, good, and.. if we think about a dish, it is not preparing that dish alone and presenting it to the student, but maybe it is preparing that dish together. To prepare a dish together with the students by using the ingredients and eating it somehow with the students... it is not only students eat, but eating it with the students and being full.. and growing up.. maybe it can be described in this way (U1).

30. Do you think that the knowledge and skills you gained in the program will be sufficient for your teaching?

I don't think that it will be sufficient. [I will feel a] need for sure.

a. What can a teacher do to improve his/her knowledge and skills?

I think that improving is a result of expectations and needs. For this reason, although it should not be connected to only these [expectations and needs], but it will be most probably in the direction of expectations and needs. In order to improve, I will use current [sources], the sources that I use in the university, internet, and different books about the issues. I will continue to use these. [I will be using] The things on the internet that the foreign schools and sites have prepared. I will make use of these. I will benefit from my friends' knowledge.

31. How would you define teaching as a profession before you started studying in this program?

Teaching.. an obligation... The life style that people come and somehow teach a class and go, and then forget the things that they taught. I used to view it this way for a lot of courses. Because, teachers' classroom behaviors and outside behaviors were inconsistent. And this made me think, "This is probably what all teachers do, they behave in his way since it is a duty." For me, this is so wrong. I will also try not to [do this]...actually, maybe there should be something like this, too, but the teachers'...people's impression in the classroom and at the outside should be consistent and similar.

[C: Do you think that the program courses have an effect on the change of your ideas?]

Yes, university... I think that the university courses and the university in general changed [my ideas]. I think in the positive way. I mean my experiences at the university, the student teachings I did, the educational courses that I took, and professors' impressions [on me] changed me in this way.

[C: What are your plans for future?]

Actually, while coming to the university I did not so much... Since I became a teacher by my father's guidance and since I have never thought of teaching people, being a teacher before, the idea of teaching kids was so far away from me. It was far away until my student teaching. But [used to think] I could not definitely teach to the small kids since I used to think that I would not be able to go down to their levels and I would not be able to explain [something] again if they would not understand. I was thinking of staying at the university and teaching to the people at the university level, if this idea had not changed. I mean, if the conditions were suitable, if the department were hiring grad assistants, or if I would be hired as a grad assistant, then this was more appealing for me. But after this year, I think that I will be teaching while enjoying it at the same time. Hence, I don't know what the conditions will bring, but I want both an academic career and to get involved in education. I want to study on both educational sciences and mathematics education. And at the same time, I want to teach to the younger students. I don't know what I will do, but I will probably start initially by being a teacher. And, I did not apply to all private schools. Most of the private schools required experience or I missed the deadline. For this reason, the private school alternative does not seem to be that much possible for me. I will take KPSS [a national exam for those who want to apply a governmental job, the jobs that you are hired as a civil servant]. And if it is [the place she will teach, ministry assigns] going to be somewhere close to here, I am planning to do both master and teaching. I don't want to loose this connection [with the university] in order to study on educational sciences in the future. Because I like [studying] educational sciences. If I continue [on academic work, masters degree] and if [the things] will not be in the way I want when the teaching experience is sufficient for me, then I may transfer to the universities, if it is concluded that I have the sufficient *qualifications*.

[C: Do you think that you will be able to improve yourself in public schools?]

Yes, if we don't be lazy so much. As I told, the needs.. I mean, the school's.. actually every school needs but... For instance, most of the schools do not have computers, mathematics classrooms, and materials. But we see that they can actually have [these] by the efforts of the teachers. We may just sit down since there is no need and no request. But we can also create this need and request. I probably want this happen in this way. I now feel that I will be working for this to happen this way… for this to happen… It will be, it will be like this. I mean, I think that I will be doing something. At least, if students will not be motivating me, this will happen this way.

Coding Dina's Interview

The original coding sheet requires line numbers to be indicated. Instead of giving line numbers here, the expressions indicated in the first three sections of original coding sheet are underlined. Each separate underlined expression is named with U followed by a number. For each response, the underlined expressions start with U1. No expression is underlined for the 4th, 5th, and 6th sections of the coding sheet here, only question number is given.

Coding Sheet

Participant #: 19, **Year**: 4, **Coder**: Final Coding, **Date**: April 1st, 2005

1. Belief Statements (Write the line number)

Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Line		U1	U1,U2,U3				U1		U1		U1	U1

Q	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Line		U1	U1				U1				

Q	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Line	U1, U2, U3								

Notes (if any):

- Daily life, intellectual view, providing approaches to solve problems (Q1, Q2, Q3, Q6, Q10, Q14)
- Application of knowledge to new situations (Q5, Q9, Q11)
- I learn if I enjoy/like my teacher (Q10, Q14, Q23)

2. Categories (Write the line number) N = Nature of Mathematics, T = Teaching Mathematics, L = Learning Mathematics

Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
N		U1										
T			U2				U1					U1
L			U1,U3						U1		U1	

Q	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
N											
T		U1	U1				U1				
L											

Q	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
N									
T						U1			
L	U1, U2, U3								

Notes (if any):

3. Levels (Write the level)

Q	1	2	3	4	5	6	7	8	9	10	11	12
N		0										
T			1				1-2					1
L			1, 0						2		2	

Q	13	14	15	16	17	18	19	20	21	22	23
N											
T	1	1					1				
L											

Q	24	25	26	27	28	29	30	31	32
N									
T						2			
L	1, 1, 1								

Resulting Levels:

Nature of Mathematics: 0
Teaching Mathematics: 1
Learning Mathematics: 1

Notes (if any):

4. Perceived Effect of Program Courses on Profession (positive (+), negative (-); Q number; Line Number)

Course/ Dept.	Specific Course (s)	Prof.	Project	Presentation	Assignment	Need	Note
Math	+, Q27, (111, 112)						
EME	+, Q27 (method)	-, Q27		+, Q27 -, Q27	+, Q27	Q27	
EDS	+, Q27 (guidance)						

Teaching Experience: None

5. School Effect on Ideas about Mathematics (positive (+), negative (-); Q number; Line number)

School Level	Specific Teacher	Specific Course	Specific Year	Notes
Elementary School				
Middle School				
High School	+, Q24, Geometry	+, Q24, Geometry	+, Q24; -, Q24	

High School Background: Science High School

6. Teaching and Learning Mathematics Concepts

Concepts enjoyed in teaching (or criteria of concepts that are enjoyed in teaching):

Geometry, Q19; Angles and expressions, Q19:
Use of material, Q19; Students, Q19

Concepts not enjoyed in teaching (or criteria of concepts that are enjoyed in teaching):

-, Abstract concepts, Q19

Concepts enjoyed in learning (or criteria of concepts that are enjoyed in learning):

Q20-Q21; Geometry, Q24; Teacher enjoyment, Q23

Concepts not enjoyed in learning (or criteria of concepts that are enjoyed in learning):

Quotable quotes:

APPENDIX E

A MEMO FOR ELEMENTARY MATHEMATICS EDUCATION PROGRAM

I have been informed that the Elementary Mathematics Education (EME) Programs are going to be evaluated soon for their effectiveness in preparing middle school mathematics teachers. My doctoral study is about the impact of the METU EME program on preservice and inservice teachers' mathematics related beliefs, but it is also partly concerned with its effectiveness in general. Here, I provide a short summary of my results in relation to students' program experiences and my suggestions for the changes in METU EME program, which I believe can be applicable to the other EME programs in Turkey. I also propose ideas for a broader change in teacher education and beginning teacher mentoring programs. The evidences for the results and suggestions are presented in my dissertation which will be available for your review in mid June. I will be happy to have conversations with you in the future about new directions to improve the program.

I interviewed 12 inservice participants who are 2003 graduates of EME program both when they graduated in 2003 and after their first-year of teaching in 2004. I refer them as *first-year teachers*. I interviewed 20 students from the 2^{nd}, 3^{rd}, and 4^{th} year of the program in 2004. I refer them as *preservice teachers*.

The results and implications for the EME program, the Department of Elementary Education, and broader educational contexts are provided below.

I. Program Courses and Needs

The results of the study showed that the courses are not impacting preservice teachers' mathematics related beliefs when they are not specifically designed to challenge these beliefs. The elective course "Activity Based Problem Solving" seems to be a good example of how a course would impact preservice teachers' beliefs. Most of the first-year participants referred to this course (which was offered only to 2003 graduates) as an eye-opening course which challenged their views about teaching and learning mathematics. However, only few preservice participants slightly referred to some of the program courses during the 2004 interviews.

An important experience lacking in the program courses is the sufficient practice of learned skills, in methods and classroom management courses. Especially first-year teachers expressed this in both 2003 and 2004 interviews. First-year teachers claimed that although they learned different methods of mathematics teaching, they had difficulty in implementing these skills in the real-classroom settings because of lack of practice during the methods courses. Clearly, practice teaching course does not give sufficient teaching experience to the preservice teachers. When first-year teachers started to teach in public schools, they mostly experienced reality shock since they were not prepared to manage contextual factors and could not implement their skills. In order to reduce the reality shock, (i) managing student differences in learning, (ii) maintaining national curriculum pace and (iii) maintaining good relationships with school administrators and parents should be emphasized in the program courses. The course content related to these issues as well as teaching and learning mathematics should be supported by continuous, immediate, and critical practice and monitoring in real-classroom settings. This will be revisited in the second section.

I am aware that EME program courses which are not offered by the program faculty are beyond our control. However, the related program faculty should be contacted and communicated about our students' needs in these courses (e.g. Introduction to Teaching Profession and Classroom Management). I realized that students' experiences in especially Introduction course is critical to the perception of teaching as a profession which requires more than dictating some form of knowledge to the students.

Methods courses in EME program emphasize teaching, but do not seem to refer to students' learning and the nature of mathematical knowledge that should be in the mathematics classrooms. If we emphasize and challenge them about the nature of mathematical knowledge and how it should be represented in the classrooms in these courses, this may help our students in developing higher level beliefs about the nature of mathematical knowledge. Teaching methods of mathematics are not generally considered in relation to students' learning. Many first-year teachers considered using manipulatives in the mathematics classroom to increase students' interest, rather than to increase their learning. We should emphasize and challenge our students about the goal of using different pedagogical approaches.

First-year teachers and some of the preservice teachers claimed an important issue as lacking in the EME program: The lack of communication among professors who teach the first and the second methods courses. They mostly claimed that it would be better if the second course was offered by the professor who offered the first course. Here, I claim that there should be continuous communication across the program faculty through all courses to make latter course experiences build on the former ones. This would also make the courses more meaningful for the students and increase their perception of the usefulness of course experiences.

II. Relationship with the Ministry of National Education and Long Term Policies

The results of the study indicated that there is a lack of communication between EME program faculty and the Ministry of National Education staff working on teacher education and teacher induction. A close communication is needed in order to provide preservice teachers with more teaching experiences during their studies in our program and to support our graduates during their initial years in teaching.

EME programs can be organized better to prepare teachers for initial years more realistically. We send our graduates to the field with high expectations from themselves, their students, school settings, and the curriculum, which results in a clash of ideals when faced with the real-classroom contexts. In order to provide EME program students with more real-classroom practice during their program studies, an increasing number of skillful and helpful teachers should be recruited as mentors. This requires a new policy for the Ministry and collaborative efforts of both our program and the Ministry staff in training the mentors and organizing the teaching experiences for students.

Mentoring in the first-year teachers in Turkey is not a working system. Most of the first-year participants mentioned the need for a critical eye for their teaching or a feedback from an experienced teacher. However, first-year participants did not even meet their mentors assigned to monitor their teaching. Ministry should be contacted about the need for an effective mentorship policy that would help beginning teachers in their initial years. University collaboration in an effective mentorship policy is likely to provide beginning teachers and mentors with ideas and materials when they need it.

Perhaps, the most important issue that should be communicated to the Ministry is the limiting impact of beginning teacher recruitment policies on beginning teachers' teaching. Most of the first-year participants in this study were recruited later in the first or second semester of the school year. Our graduates were generally the first mathematics teachers who were recruited since the beginning of the school year. The previous teachers who taught mathematics in these schools were not mathematics teachers. Hence, first-year teachers' students lacked essential mathematical knowledge and skills. Therefore they had difficulties in managing the national curriculum pace and students' missing knowledge simultaneously.

Beginning teachers are under the pressure of being inspected by the Ministry for the national curriculum pace and revisiting previously "taught" concepts that students have no knowledge or skills. Clearly, a beginning teacher who starts teaching in March at a rural public school (which did not have a single mathematics teacher since the beginning of the school year) cannot keep the curriculum pace without ignoring the lack of students' prior knowledge. The dilemma of keeping the curriculum pace or teaching for students' learning which was expressed by most of the first-year participants should be communicated effectively to the Ministry.

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