# PRE-SERVICE AND IN-SERVICE HIGH SCHOOL MATHEMATICS TEACHERS' BELIEFS AND VIEWS ABOUT USING CALCULATORS

A MASTER'S THESIS

BY

PELİN KONUK

THE PROGRAM OF CURRICULUM AND INSTRUCTION
BILKENT UNIVERSITY
ANKARA

MAY 2014

*To my family with love…*

# PRE-SERVICE AND IN-SERVICE HIGH SCHOOL MATHEMATICS TEACHERS' BELIEFS AND VIEWS ABOUT USING CALCULATORS


The Graduate School of Education

of

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by

Pelin Konuk


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THESIS TITLE: PRE-SERVICE AND IN-SERVICE HIGH SCHOOL MATHEMATICS TEACHERS' BELIEFS & VIEWS ABOUT USING CALCULATORS

PELİN KONUK

May 2014

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

…….

Assoc. Prof. Dr. Erdat Çataloğlu

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

…….

Prof. Dr. Arif Altun

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

…….

Dr. Armağan Ateşkan

Approval of the Graduate School of Education

…….

Director: Prof. Dr. M. K. Sands

## ABSTRACT

PRE-SERVICE AND IN-SERVICE HIGH SCHOOL MATHEMATICS TEACHERS' BELIEFS AND VIEWS ABOUT USING CALCULATORS

Pelin Konuk

M.A., Program of Curriculum and Instruction
Supervisor: Associate Professor Erdat Çataloğlu

May 2014

The purpose of the study was to explore Turkish high school pre-service and in-service mathematics teachers' beliefs and views about using digital technology, particularly calculators, in their mathematics classrooms. The Ministry of National Education (MoNE) has recently put into practice a smart class project (FATİH Project) to equip 42000 schools and 570000 classes across the nation with the state of art information hardware (MoNE, 2012a). In this context, the results and findings of this timely research are of great significance as it aims at exploring Turkish pre-service and in-service high school mathematics teachers', views and beliefs about using digital technology, calculators in particular, during mathematics instruction.

The research study was conducted with 60 pre-service and in-service high school mathematics teachers from two different universities and five different high schools in Turkey. A survey was used as a data collection tool in the present study. The survey consisted of 23 Likert type questions, and all the questions were analyzed in

three categories. Both the pre-service and in-service participants have responded to the same survey questions within the research study. Pre-service high school mathematics teachers participated to the study by responding online survey questions in April and June 2013. In-service high school mathematics teachers participated to the study by responding the same survey questions by using paper and pencil in November and December 2013.

Frequency tables and Mann Whitney *U* test were used to analyze the descriptive data. The study revealed that there was a statistically significant difference between the pre-service and in-service high school mathematics teachers' responses to survey questions about using calculators, in their classrooms. The findings of the research study were evaluated with a special emphasis on the participants' technological pedagogical knowledge, experience with technology and calculators, the teacher education programs they have attended and their willingness to use digital technology, specifically calculators, during mathematics instruction.

Key words: Calculator, digital technology, FATİH Project, technological pedagogical content knowledge.

# ÖZET


HİZMET ÖNCESİ VE HİZMET İÇİ LİSE MATEMATİK ÖĞRETMENLERİNİN HESAP MAKİNESİNİ KULLANMA KONUSUNDAKİ İNANÇ VE GÖRÜŞLERİ

Pelin Konuk

Yüksek Lisans, Eğitim Programları ve Öğretim

Tez Yöneticisi: Doçent Doktor Erdat Çataloğlu

Mayıs 2014

Çalışmanın amacı, Türkiye'deki liselerdeki hizmet öncesi ve hizmet içi matematik öğretmenlerinin, matematik derslerinde dijital teknoloji, özellikle de hesap makinesi kullanımına, ilişkin inanç ve görüşlerini ortaya koymaktır. Son dönemde Milli Eğitim Bakanlığın tarafından ülke çapındaki 42.000 okulu ve 570.000 dersliği en yeni bilişim teknolojileri hizmet içi matematik öğretmenlerinin, matematik öğretimi esnasında dijital ile donatmak için bir akıllı sınıf projesi (FATİH projesi) uygulamaya konulmuştur (Milli Eğitim Bakanlığı, 2012). Bu bağlamda, Türk liselerindeki hizmet öncesi ve teknoloji, özellikle de hesap makinesi, kullanımına ilişkin inanç, ve görşlerini tespit etmeyi amaçlayan bu çalışmanın ortaya koyduğu sonuçlar zamanlaması bakımından büyük önem arz etmektedir.

Çalışmaya konu olan araştırma, Türkiye'de iki ayrı üniversite ve beş ayrı liseden toplam 60 hizmet öncesi ve hizmet içi öğretmenin katılımı ile gerçekleştirilmiştir. Çalışmada veri toplama aracı olarak anket yönetimi kullanılmıştır. Anket 23 "Likert" tipi sorudan oluşmuştur ve tüm sorular üç kategoride analiz edilmiştir. Gerek hizmet

öncesi gerekse hizmet içerisinde yer alan katılımcılar aynı soruları yanıtlamışlardır. Hizmet öncesi lise matematik öğretmenleri çalışmaya Nisan ve Haziran 2013 ayları arasında çevrim-içi anket sorularını yanıtlayarak katılmışlardır. Hizmet içi lise matematik öğretmenleri ise aynı soruları Kasım ve Aralık 2013 ayları içerisinde kağıt ve kalem kullanarak yanıtlamışlardır.

Betimleyici verilerin analizinde sıklık tabloları ve "Mann Whitney *U*" testi kullanılmıştır. Çalışma, hizmet öncesi ve hizmet içi matematik öğretmenlerinin anket sorularına verdikleri cevaplarda sınıflarında dijital teknoloji, özellikle de hesap makinesi, kullanımı konusunda istatistiksel olarak önemli farklılıklar olduğunu ortaya koymuştur. Çalışmanın sonuçları, katılımcıların teknolojik pedagojik alan bilgisini, teknoloji ve hesap makinesi kullanımı konusundaki tecrübelerini, almış oldukları öğretmenlik eğitimini ve matematik öğretimi esnasında dijital teknoloji kullanımı konusunda ne kadar istekli olduklarına da vurgu yapılarak irdelenmiştir.

Anahtar Kelimeler: Hesap makinesi, dijital teknoloji, FATİH Projesi, teknolojik pedagojik alan bilgisi.

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# CHAPTER 1: INTRODUCTION

## Introduction

Technology has become an indispensable part of our lives. People from all walks of life use technology as part of their everyday and professional lives and educators are no exception. Almost everyone in the field of education, from primary school teachers to professors, makes extensive use of technological devices and tools in their teaching environment. After the National Council of Teachers of Mathematics (NCTM) had defined *technology principle* for teaching and learning mathematics, it became an important objective for mathematics educators to benefit from technological tools and integrate technology into their instructional process (NCTM, 2000).

Mathematics teachers are important change agents for integrating technology into classrooms. It is a well-known fact that teachers' beliefs, attitudes and views about using technology have an impact on their future use of technology in classrooms. This research study aims to find out Turkish pre-service and in-service high school mathematics teachers' beliefs and views towards using digital technology, particularly calculators in mathematics instruction. The results and findings of the present study will help to reflect the current situation regarding the use of technology in Turkish mathematics classrooms.

## Background

Over the past decades, there has been an increase in the use of technology in every field of life. Parallel to this increase, the necessity of the use of technology in education came out. In order to highlight the importance of using technology in mathematics teaching and learning process, the National Council of Teachers of Mathematics defined the use of technology in mathematics instruction as one of the six principles of teaching and learning mathematics (NCTM, 2000). With the introduction of a technology principle by the NCTM and the development of technological educational tools, mathematics educators have become more aware of the need for integrating technology into their instructional process.

This holds true for the Turkish education system as well. Realizing the importance of technology during instruction, Turkey has made two major curriculum changes regarding the use of technology in the last decade. In addition to these curriculum changes, in the year 2010, Turkey began to implement FATİH Project. With this Project, the Ministry of National Education (MoNE) aims to improve the use of technology in Turkish classrooms by giving equal opportunity to every single student to use and get benefit from technological tools during teaching and learning process in public schools (MoNE, 2012b).

It is obvious that among some other factors the mathematics teachers will play an important role in the process of integrating technology into mathematics classrooms. Calculators are generally thought to be one of powerful technological teaching tools available for mathematics teachers to use during mathematics instruction (NCTM, 1989). Because of this reason, there have appeared several research studies

conducted to find out mathematics teachers beliefs about using digital technology particularly calculators in mathematics instruction. According to a research study, mathematics teachers' views, attitudes and prior knowledge about using calculators have an impact on their use of calculators in mathematics instruction (Doerr & Zangor, 2000). This is also true for Turkey. According to several research studies conducted in Turkey, most mathematics teachers think that calculators should be used in mathematics instruction as an instructional tool because they have many advantages in teaching and learning process. Some of those advantages can be summarized as follows, (i) calculators motivate students towards mathematics learning, (ii) calculators encourage students to do mathematical inquiry, (iii) calculators are suitable for real-life scenarios, (iv) calculators enhance students' learning and make them active participants to lesson (Ardahan & Ersoy, 2002; Göğüş, 2008; Idris, 2006). Moreover, most mathematics educators believe that calculators can be used as an instructional tool for realizing more than one aim during mathematics instruction (Doerr & Zangor, 2000; Fleener, 1995).

Mathematics teachers seem to be divided on the benefits of calculators in mathematics classrooms (Ardahan & Ersoy, 2002; Göğüş, 2008; Idris 2006). According to Doerr and Zangor (2000), mathematics teachers can use calculators as "computational tool, visualizing tool, transformational tool, data collection and analysis tool and checking tool" during mathematics teaching and learning process (p.151). Doerr and Zangor (2000) argue that teachers can use calculators as computational tool because calculators enable students to evaluate or check complex computations in a very short time. As calculators can visualize solutions of problems by drawing graphs, they can be used as a visualizing tool during instruction.

Calculators enable data collection and analysis, thereby helping students to connect mathematics with real-life concepts and evaluate real-life data. Calculators are also defined as transformational tools because most teachers believe that with the help of calculators students can learn more easily and faster so teachers do not need to allocate time for further explanations during the instruction. Moreover, calculators can be used as checking tools because they enable students to check their solutions in a very short time and encourage them to do mathematical investigation (Doerr & Zangor, 2000). As calculators have many advantages for mathematics instruction, it has become a requirement for mathematics teachers to integrate this technology into their instruction.

As technology directed by powerful software to a multi-purposed devices, it becomes harder for most teachers to follow the latest developments in technology. Furthermore, most teachers find it challenging to integrate technology into their instructional process (Zhao, 2003). One research study revealed that most teachers do not feel comfortable about integrating technology into their instructional process mainly because of their lack of knowledge about it (Ardahan & Ersoy, 2002). It was Shulman (1986), who first defined the term pedagogical content knowledge as teachers' subject area knowledge for teaching and learning. With the advancements in technology and the ever-increasing necessity for technology in education, a new term was born: "technological pedagogical content knowledge." Today the term has a definition: teachers' knowledge about how to use and integrate technology effectively during instruction (Koehler & Mishra, 2009). As teachers are one of the key factors in integrating technology into classrooms, Turkey has begun to implement some changes in teacher education programs and develop projects to

educate teachers about how to teach by using technology in order to improve the use of technology in classrooms (Gürol, Donmuş, & Arslan, 2012).

In 2010, FATİH Project began to be implemented in Turkey in order to create student-centered education system and to establish equity in using technology for every single student in education (MoNE, 2012a). Within this project, public schools are planned to be provided with the necessary technological equipment in order to extend the use of technology in teaching and learning process all over the country (Akgün, Yılmaz, & Seferoğlu, 2011). In addition, with this project, Turkish educators aim to increase students' achievement by enabling them to use technology for real-life situations on national and international platforms (Çelen, Çevik, & Seferoğlu, 2011). At this point, because teachers are one of the most important change agents for implementing this project in classrooms, it becomes significantly important for Turkey to identify and improve teachers' knowledge of how to teach effectively with using technology in other words their technological pedagogical and content knowledge.

## Problem

In the last decade, there have been major changes in Turkish high school curriculum in terms of the use of technology. Recent Turkish high school curriculum dictates the use of technological educational tools in mathematics instruction (MoNE, 2013). Moreover, the Ministry of National Education is in the process of implementing FATİH Project in order to increase the use of technology in instructions. As mathematics teachers are one of the most important change agents for integrating these innovations successfully into classrooms, it has become necessary to find out

Turkish mathematics teachers' beliefs and views about the potential benefits of using digital technology, particularly calculators, in classrooms.

## Purpose

This research study aims to explore Turkish high school pre-service and in-service mathematics teachers' beliefs and views about using the use of calculators in their mathematics classrooms. By identifying the differences between pre-service and in-service Turkish high school mathematics teachers' beliefs and views about using this technology, it attempts to provide insights into the implementation of FATİH Project and reflect the current situation in Turkish mathematics classrooms regarding the use of calculators and teachers' technological pedagogical content knowledge.

## Research questions

The research questions of this study are as follows:

1. What beliefs and views do **in-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?
2. What beliefs and views do **pre-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?
3. Is there a statistically significant difference between pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?
4. Is there a statistically significant difference between male and female high school mathematics teachers' (pre-service and in-service) beliefs and views about using digital technology specifically calculators in mathematics classrooms?

5. Is there a statistically significant difference between in-service private and public high school mathematics teachers' beliefs views about using digital technology specifically calculators in mathematics classrooms?

6. Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education program from public universities and those from private universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms?

## Significance

Calculators are generally thought to be one of powerful technological teaching tools available for mathematics teachers to use during mathematics instruction (NCTM, 1989). Moreover, they are cheap and easy to access, helpful for teachers to make mathematics easier and more enjoyable to understand during instruction (Waits & Demana, 2000). As has been made clear in the foregoing, the need to find teachers' beliefs and views towards using technology, particularly calculators, in mathematics teaching and learning process has become increasingly important as they play a crucial role in the integration of technology into classrooms. In this context, the present study could contribute not only to literature, but also to the project implemented by the Ministry of National Education by providing information about pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology, specifically calculators, in mathematics instruction.

At the local level, this research study aims to find out pre-service and in-service high school mathematics teachers' beliefs and views about using calculators during mathematics instruction. Several research studies have revealed that teachers'

beliefs, views and experiences towards using a teaching method or teaching tool affect their teaching and learning process (Ball, Lubienski & Mewborn, 2001; Özgün-Koca, 2009). Thus, this research study attempts to explore whether digital technology specifically calculators will be used as an instructional tool in Turkish mathematics classrooms or not.

It should also be noted that this is a timely study because although FATİH Project requires the use of technological tools in classrooms, it does not force teachers to use these technological tools during instruction. It has therefore become significantly important to find out Turkish mathematics teachers' beliefs and views towards using this type of technology in classrooms in order to have an idea about the future use of technological tools in Turkish classrooms.

## Hypotheses

Firstly, a null hypothesis and an alternative hypotheses were defined in order to compare the mean ranks of the participant in-service and pre-service high school mathematics teachers' scores to answer the research question: "Is there a statistically significant difference between pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?" A null hypothesis and an alternative hypothesis were specified as follows:

$H_0$: There was not a statistically significant difference between the mean ranks of pre-service and in-service high school mathematics teachers' views and beliefs about using calculators in their classrooms.

$H_1$: There was a statistically significant difference between the mean ranks of pre-service and in-service high school mathematics teachers' views and beliefs about using calculators in their classrooms.

Secondly, in order to respond the research question: "Is there a statistically significant difference between male and female high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?" A null hypothesis and an alternative hypothesis were specified as follows:

$H_0$: There was not a statistically significant difference between the mean ranks of male and female high school mathematics teachers' views and beliefs about using calculators in their classrooms.

$H_1$: There was a statistically significant difference between the mean ranks of male and female high school mathematics teachers' views and beliefs about using calculators in their classrooms.

Thirdly, in order to respond the research question: "Is there a statistically significant difference between in-service private and public high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?" A null hypothesis and an alternative hypothesis were specified as follows:

$H_0$: There was not a statistically significant difference between the mean ranks of in-service private and public high school mathematics teachers' views and beliefs about using calculators in their classrooms.

$H_1$: There was a statistically significant difference between the mean ranks of in-service private and public high school mathematics teachers' views and beliefs about using calculators in their classrooms.

Finally, a null hypothesis and an alternative hypothesis were stated to respond the research question: "Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education program from public universities and those from private universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms?" as follows:

$H_0$: There was not a statistically significant difference between the mean ranks of pre-service high school mathematics teachers who received their teacher education program from private universities and those from public universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms.

$H_1$: There was a statistically significant difference between the mean ranks of pre-service high school mathematics teachers who received their teacher education program from private universities and those from public universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms.

## Definition of key terms

Calculator: A hand-operated electronic device or a piece of software that performs calculations (Webster, 1992).

Content knowledge (CK): Content knowledge refers teachers' knowledge about their subject areas (Shulman, 1986).

Pedagogy knowledge (PK): Pedagogy knowledge refers teachers' knowledge about teaching methods and procedures. (Shulman, 1986).

Technology knowledge (TK): Technology knowledge refers teachers' knowledge about using technological tools (Shulman, 1986).

Technological pedagogical content knowledge (TPCK): Technological pedagogical content knowledge refers teachers' knowledge about how to integrate and use technology effectively in their teaching and learning process (Koehler & Mishra, 2005).

MoNE: The Ministry of National Education.

NCTM: The National Council of Teachers of Mathematics.

## Summary

In this chapter, the scope of the study was presented through a discussion of the problem statement, the background and significance of the study, its purpose and research questions. This chapter also includes the hypotheses which shall be discussed at length in the following chapters through comprehensive research questions. The definitions of the key terms were also included in this chapter in order to help the reader to understand the commonly used terms better. In Chapter 2 several research-based and theory-based articles will be analyzed in order to provide a better understanding and different perspectives about the research study.

# CHAPTER 2: REVIEW OF RELATED LITERATURE

## Introduction

This research study is intended to find out Turkish pre-service and in-service high school mathematics teachers' beliefs and views towards using digital technology specifically calculators in mathematics teaching and learning process. This chapter aims to analyze several research-based and theory-based articles in order to provide a wider perspective about the research study under five main parts: mathematics education with technology, calculators as instructional tools, technological pedagogical content knowledge, FATİH Project and teacher education programs and the relationship between these programs and technology in Turkey.

The first part provides general information about mathematics education with using technology. Besides that it also provides information about the latest curriculum changes designed to integrate technology into Turkish classrooms. It is followed by an explanation on calculators as instructional tools which focuses on teachers' beliefs and perceptions about both the advantages and disadvantages of using this digital technology in classrooms during mathematics instruction. The second part also provides detailed information about several research-based articles and presents their findings about the advantages and disadvantages of using calculators and teachers' beliefs and views about using this technology during mathematics instruction. The third part first presents the definition of technological pedagogical and content knowledge and then highlights high school mathematics teachers' technological, pedagogical and content knowledge. The fourth part provides information about

FATİH project developed by the Ministry of National Education in order to provide every student an equal opportunity to benefit from technology and increase the use of technology in Turkish classrooms. Finally, the fifth part provides information about high school mathematics teacher education programs and their relationship with technology in Turkey.

## Mathematics education and technology

The National Council of Teachers of Mathematics (NCTM) defines *technology principle* as one of its six principles of teaching and learning mathematics. The principle states that "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, 2000, p.24). After the NCTM introduced the technology principle and the development of technological tools, mathematics educators have become more aware of the need for integrating technology into their instructional process all over the world. Numerous mathematics educators from different countries declared that there were many different ways to integrate technology into mathematics lessons and benefit from it (Durmuş & Karakirik, 2006; Fey, 1989). Most mathematics educators reported that having access to technology during mathematics lessons have a positive impact on students' achievement (Attewel & Battle, 1999). Moreover, mathematics educators stated that with the help of technology, students can develop an understanding of complex mathematical concepts more easily, and it can therefore be concluded that the use of technology helps to enhance students' learning (Hooper & Rieber, 1995; Keong, Horani, & Daniel, 2005).

This is also true for Turkey. Realizing the importance and advantages of integrating technology into teaching and learning process, the Ministry of National Education (MoNE) has begun to make changes in the curriculum and educational objectives of different disciplines. MoNE has begun to integrate technology into the educational objectives of various courses in order to maximize student achievement and help them to cultivate positive attitudes towards learning by providing students a chance to learn how to use and benefit from technology (Çelen, Çevik, & Seferoğlu, 2011). In the last decade, Turkey has made two major curriculum changes regarding the use of technology in order to improve the success of education system and provide better conditions for students and teachers in teaching and learning process (Akşit, 2007). The first aim of the curriculum reform was to take advantage of information and communication technologies and help students to develop a better and clearer understanding of complex concepts (MoNE, 2013). Moreover, how students apply their knowledge in real-life concepts has become another important objective for Turkish educators (Argün, Arıkan, Bulut & Sriraman, 2010). To realize this objective, Turkey began to implement "increasing opportunities and improvement of technology movement" with FATİH project in 2010. With this project, the Turkish Ministry of Education intends to provide every student with an equal opportunity to benefit from technology and technological educational tools in teaching and learning process in Turkish public schools (Kayaduman, Sarıkaya, & Seferoğlu, 2011).

## Calculators as instructional tools

Technological tools, such as graphing calculators, computers, interactive whiteboards and tablet PCs have been introduced with the hope to increase the quality of mathematics education (Ersoy, 2003). After the NCTM stated that using

calculators is a key component of curriculum and evaluation standards for school mathematics, it became crucial for mathematics teachers to know how to use and integrate this technology into their instructional processes (NCTM, 1989). After the publication of the standard about using calculators, many research studies have been conducted in order to find out the advantages and disadvantages of using calculators in mathematics education. According to several mathematics teachers, there are many advantages of using calculators in mathematics instruction. Mathematics teachers list the advantages of using calculators in their classes as follows, (i) calculators are motivational tools, (ii) calculators are helpful to check the solutions in a shorter time than traditional methods, (iii) calculators are applicable to real-life concepts, (iv) calculators enable to visualize solutions, (v) calculators encourage students to do mathematical exploration and investigation, (vi) calculators help students to feel more comfortable while solving mathematics problems (vii) calculators are effective ways to teach mathematics because they are helpful to increase students' achievement (Close, Oldham, Shiel, Dooley, & O'Leary, 2012; Doerr & Zangor, 2000; Idris, 2006; Pierce, Stacey, & Barkatsas, 2007).

Several research studies revealed that teachers use calculators because they motivate students towards learning mathematics and help them to cultivate positive attitudes towards mathematics (Ardahan & Ersoy, 2002; Idris 2006). Ardahan and Ersoy (2002) conducted a research study in order to learn pre-service mathematics teachers' perceptions about using calculators during mathematics instruction. To this end, they conducted a survey with 28 pre-service mathematics teachers in Turkey. Their survey consisted of two sections, and there were Likert type survey questions. While the first section was about pre-service mathematics teachers' prior knowledge

and experiences with calculators, the second section focused on pre-service mathematics teachers' views and perceptions about using calculators after they got enough experience. After the pre-service mathematics teachers answered the questions in the first section of the survey, they attended a workshop about how to use calculators during mathematics instruction. Right after the workshop, the teachers applied the methods they had learned in the workshop in their mathematics lessons. Then, the pre-service mathematics teachers answered the questions in the second section of the survey related to their perceptions and views about using calculators during mathematics teaching and learning process. After the analysis of the results, Ardahan and Ersoy (2002) concluded that 94% of the participant pre-service mathematics teachers reported that using calculators during mathematics instruction motivated students towards learning, and it made mathematics more fun.

Calculators generally save time. Hence, mathematics teachers think that they can make more explanations about mathematical concepts rather than solving one single question during the lesson (Göğüş, 2008; Simmt, 1997). Göğüş (2008) conducted a research study in order to learn teachers' views about benefits of integrating calculators into high school mathematics lessons. The study was conducted with 13 high school mathematics teachers in New York, the USA. Data was collected with the help of a questionnaire, interviews and classroom observations. The collected data, separated into codes and themes, were analyzed carefully, and the research questions were answered accordingly. After the data analysis, Göğüş (2008) concluded that although mathematics teachers mostly found it useful to use calculators during mathematics instruction, they had some reservation about it. However, 62% of high school mathematics teachers believed that using calculators

helped them to save time during lesson period. The mathematics teachers mainly stated that drawing graphs and calculating were much easier with calculators and that they had more time to make explanations about important mathematical concepts rather than spending time on calculations or drawings.

Calculators enable students to use, analyze and solve real life problems (Doerr & Zangor, 2000). Doerr and Zangor (2000) conducted a research study in order to find the possible uses of calculators that teachers and students can make during mathematics teaching and learning process. As part of the study, the research team observed two classrooms for 21 weeks in order to find the different uses of calculators in mathematics instruction. Audiotapes, field notes and interviews were used to collect the necessary data. Data were analyzed according to the different usage that students and teachers used calculators during mathematics teaching and learning process. After the data analysis, it revealed that apart from other modes of calculator use, teachers and students mostly used calculators for analyzing real-life data. The research team reported that students enjoyed working with real-life data. According to research team's findings, students enjoyed to decide the reliability of the real data-set and then analyze the data by using calculators. Using calculators to find real objects areas, solve real-life problems and analyze real-life data encouraged students to do and learn mathematics.

Using calculators also enabled students to see different representations of complex solutions and thus students were able to develop better understanding of complex mathematical concepts (Demana, 2000; Hennessy, Fung, & Scanlon, 2001). Hennessy, Fung and Scanlon (2001) conducted a research study in order to explore

the effects of using calculators during mathematics instruction. Within the research study, students were first taught how to use calculators in mathematics lesson. Then, the mathematics teachers wanted the students to do their coursework by using calculators. A survey was designed with the participant of 55 students in the United Kingdom to learn students' perceptions about using calculators. After the data analysis, the survey results revealed that 78% of the students agreed that calculators helped them to understand complex mathematical concepts more easily by showing them multiple representations of solutions. The students mainly stated that they understood the solutions better because using calculators helped them to decide which method was easier for them by showing multiple representations. Therefore, the researchers' findings supported that using calculators help students to develop a better understanding of complex mathematical concepts and thus mathematics seems easier for students to learn.

Using calculators helps students to feel more comfortable about mathematics and thus it helps them to increase their achievement and feel more confident while doing mathematics (Idris, 2006). Idris (2006) conducted a research study with 109 students in Malaysia in order to find out the effects of using calculators on students' achievement during mathematics instruction. The research study consisted of two sections: students' mathematics scores and students' nervousness scores. During the research study, there were experimental and control groups. To find the differences between the two groups, a pre-test and post-test design was conducted. While the experimental group studied mathematics by using calculators, the control group studied mathematics with traditional paper and pencil method for ten weeks. At the end of ten weeks, the results of the pre-test and post-test design were analyzed by

using Statistical Package for the Social Sciences (SPSS). According to the pre-test and post-test results, Idris (2006) summarized that the experimental groups' mathematics achievement were significantly higher than that of the control groups. Additionally, the experimental group, who studied mathematics with calculators, were far more confident while dealing with mathematics problems when compared to the control group (Idris, 2006).

Conversely, some mathematics teachers highlighted the disadvantages of using calculators in mathematics teaching and learning process. According to them, calculators may not be an effective teaching tool all the time. Some mathematics teachers stated,

Using calculators may cause serious problems in the future because students may want to do all the calculations with calculators and thus they can lose their basic arithmetic skills (Ardahan & Ersoy, 2002; Fleener, 1995; Özgün-Koca, 2009).

It is very hard to control all the students when dealing with calculators because they may not be interested in solving questions and do something else instead (Ardahan & Ersoy, 2002; Göğüş, 2008). In Göğüş's (2008) research study it has been revealed that mathematics teachers generally complain about students' misbehaviors when they are using calculators. Mathematics teachers mainly stated that most of the students chatting, texting or playing with the calculators rather than solving mathematics problems. Thus, according to them calculators may not be effective tools during instruction.

It is hard and time-consuming to learn how to use and integrate this technology into mathematics teaching and learning processes (Ardahan & Ersoy, 2002; Simonsen & Dick, 1997).

Mathematics teachers may have adaptation problems while using calculators during mathematics instruction. Because most of the mathematics teachers have not used calculators during their schooling, it may be hard for them to learn effective ways to use this technology (Chamblee, Slough, & Wunsch, 2008).

As can be seen in the foregoing discussion mathematics teachers seem to be divided on the benefits of calculators in mathematics classrooms (Ardahan & Ersoy, 2002; Göğüş, 2008; Idris 2006). Mathematics teachers' knowledge, belief and views about how to use and integrate technology helps us to predict their future use of calculators in their instructional process (Ball, Lubienski, & Mewborn, 2001; Burrill et al., 2002; Özgün-Koca, 2009). It is for this reason that it has become noteworthy to find out mathematics teachers' both pre-service and in-service knowledge and views about using this digital technology in instruction. The results to be obtained from such a study may help policymakers to decide whether or not this technology will be used in classrooms in the future.

**In-service and pre-service high school mathematics teachers' beliefs and views about using calculators**

Calculators have been accepted as one of the effective teaching and learning tool in mathematics education (Waits & Demana, 2000). Because calculators have such an important place in mathematics teaching and learning process, research studies have

begun to be conducted in order to find out in-service and pre-service high school mathematics teachers' beliefs and attitudes about using this technology in their classrooms.

To find in-service high school mathematics teachers' perceptions about using calculators during instruction, Baki and Çelik (2005) conducted a research study with 14 in-service high school mathematics teachers in Turkey. As a part of the research study, participants' perceptions about using calculators during mathematics instruction were analyzed before and after they have attended a five day workshop about how to use this technology effectively in classrooms. Results of the study revealed that, before attending to the workshop nearly all of the in-service high school mathematics teachers indicated that mathematics can be learn best only if teachers explain concepts without using calculators. However, after attending to the workshop and learning effective ways to use calculators 72% of the participants indicated that they believe the positive effects of using this technology and want to use in their classrooms. Similarly, in order to find out in-service mathematics teachers' perceptions about using calculators in their instructional process, Ersoy (2002) conducted a research study with 65 teachers. Research study lasted for three days. Within the research study, participants answered to the survey questions which focus on their desires and willingness to use calculators in their classrooms as well as their intentions to participate and contribute to international mathematics conference. Results of the research study revealed that 90% of the in-service teachers want to use calculators and learn more about effective ways to use this technology during mathematics instruction. Another research study conducted by Fleener (1995) also revealed that in-service mathematics teachers have positive attitudes about using

calculators during instruction. Findings of the study indicated that majority (89%) of the in-service teachers believe with the correct use of calculators mathematics can be easier to understand for the students.

To find pre-service high school mathematics teachers' perceptions about using calculators during instruction, Özgün-Koca (2009) conducted a research study with 27 pre-service high school mathematics teachers in Ankara, Turkey. In order to collect the data, interviews and a survey were used. The questions focused on advantages and disadvantages of using calculators, different modes that teachers can use calculators during mathematics instruction and teachers' views about using this technology in classrooms. Results of the study revealed that pre-service high school mathematics teachers mostly indicated that calculators are motivational tools that help students to have positive attitudes towards learning mathematics. Moreover, participants pointed out that because calculators visualize the solutions, it would help students to develop understanding to the mathematical concepts easier. Similarly, in Ardahan and Ersoy's (2002) research study, 72% of the pre-service mathematics teachers indicated that they want to use calculators in mathematics teaching and learning process because of the advantages of using this technology. However, results showed that 100% of the participants indicated that even they want to use calculators they need to learn effective ways of using this technology in classrooms. Another research study conducted with the participation of 5 pre-service high school mathematics teachers revealed that pre-service high school mathematics teachers find calculators useful to visualize the solutions, save time during insturction and help students to understand the topic easier and better (Kağızmanlı & Tatar, 2012).

By looking at the results of the studies, mathematics teachers both pre-service and in-service seem to believe the positive effects of using technology particularly calculators during mathematics instruction (Baki & Çelik, 2005; Ersoy, 2002; Özgün-Koca, 2009). Because mathematics teachers' knowledge, belief and views about how to use and integrate technology helps us to predict their future use of calculators in their instructional process, their knowledge not only about technology but also about how to use technology effectively in teaching and learning process, or more precisely their technological pedagogical content knowledge, has become a topic worth investigating (Ball, Lubienski, & Mewborn, 2001; Burrill et al., 2002; Özgün-Koca, 2009).

## Technological pedagogical content knowledge

As technology changes over the years by powerful software to multi-purposed devices, it becomes difficult for most teachers to decide how to learn and integrate this technology into their instructional processes (Zhao, 2003). Since most mathematics educators have different ideas about how to use technology during mathematics instruction, their attitudes towards this issue has been a subject of discussion for many years (Grandgenett, 2008). Teachers' knowledge of and qualifications about integrating technology into mathematics education to have the maximum benefit from technology in their mathematics instruction; in other words, their knowledge about "technological pedagogical content knowledge" (TPCK), has become significantly important (Koehler & Mishra, 2005).

To define teaching profession, Shulman (1986) firstly used the term "pedagogical content knowledge (PCK)". He (1986) defined the terminology PCK as teachers'

content knowledge about how to teach effectively. According to Shulman (1986), although content knowledge and pedagogy knowledge are different from each other, teachers should know how to combine these two so as to establish an effective teaching and learning environment. Shulman (1986) first defines content knowledge as teachers' knowledge about their subject areas and related disciplines. Then, he (1986) defines pedagogy knowledge as teachers' knowledge about teaching methods and procedures. Shulman (1986) argues that even if teachers have a good content knowledge, it is not easy for them to teach effectively without having pedagogical knowledge. According to Shulman (1986), having a good content knowledge is not enough to be a good teacher. Having a good pedagogical content knowledge plays an important role in mathematics education for both teachers and students. It helps teachers make decisions about the most effective methods of teaching, and to choose the most beneficial examples and the most satisfactory explanations in order to enhance students' learning,

When Shulman (1986) first defined pedagogical content knowledge, technology was also used in classrooms. However, it was not as complex and developed as it is today (Mishra & Koehler, 2006). Today, technology has become an indispensable part of teaching and learning process with the use of computers, digital projectors, interactive whiteboards and tablet PCs. It is in this context that a new term "technological pedagogical content knowledge" (TPCK) has emerged (Niess, 2005). TPCK (See Figure 1) refers to different proportions of knowledge. Koehler and Mishra (2009) define TPCK as a framework that brings together the knowledge of technology, pedagogy and content. According to Niess (2005), TPCK means learning how to teach by integrating three categories of knowledge: technology,

pedagogy and content knowledge. While content knowledge refers to teachers' subject area knowledge, pedagogical knowledge refers to teachers' knowledge about how to teach; that is teachers' ability to teaching the subject. Technological knowledge, on the other hand, refers to the knowledge about how to use educational technologic devices and tools, such as digital projectors, calculators and interactive whiteboards effectively in teaching and learning process (Koehler & Mishra, 2006). Therefore, technological pedagogical content knowledge means to teach by integrating three different areas of knowledge: technology, pedagogy and content (Schmidt et al., 2009).

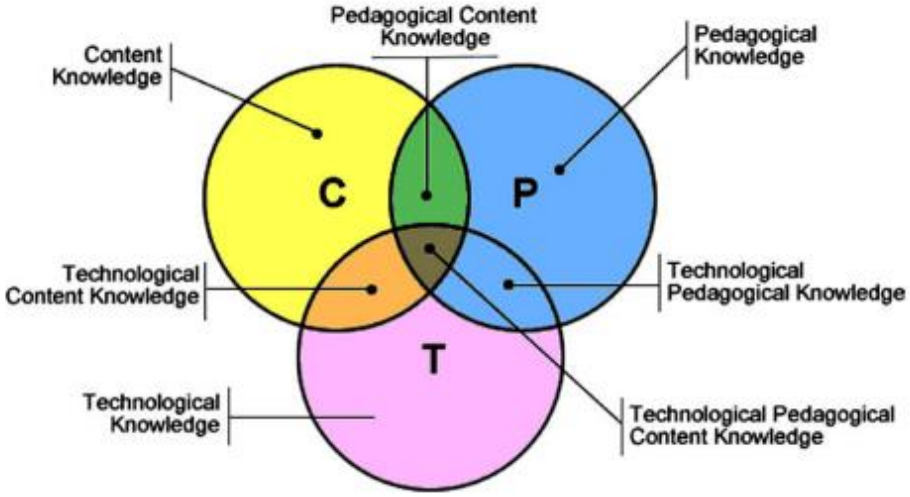


*Figure 1.* TPCK (Angeli & Valanides, 2009, p.157).

Without having technological pedagogical content knowledge, it may be hard for mathematics teachers to integrate technology, particularly calculators into their instructional process. That is why the NCTM (2008) has emphasized the importance of equipping mathematics teachers with this skill. This is also true for Turkey. Knowing that teachers are the integral parts of teaching and learning process, the MoNE (2013) urged Turkish teachers to use and benefit technology during their instruction in order to increase the use of technology in Turkish classrooms.

Moreover, in order to find out Turkish teachers' technological pedagogical content knowledge levels and their demands on using technology during instruction several research studies have begun to be conducted (Akkoç, 2011; Erdemir, Bakırcı, & Eyduran, 2009; Özgen, Narlı & Alkan, 2013). According to Özgen, Narlı and Alkan (2013), Turkish teachers are aware of positive impacts of using technology in classrooms. However, their study revealed that Turkish teachers do not feel confident about their TPCK. Thus, they do not prefer to integrate technology in their instructional process. Similarly, Erdemir, Bakırcı and Eyduran's (2009) research study revealed that teachers do not feel ready themselves to integrate technology in their classrooms mainly because they are uncertain about how to do it effectively. Moreover, Gündüz and Odabaşı (2004) reached the conclusion that because teachers' technology knowledge of technology is limited, they do not want to use it during instruction.

## FATİH Project

In the recent year, there have been some major changes in technology as well as technological educational tools. Turkey designed a smart classroom project, called FATİH project to realize the following objectives: (i) to catch up with the latest innovations in technological educational tools, (ii) to increase the use of technology among Turkish teachers, (iii) to enhance the quality of education, (iv) to establish equal opportunity for every student (MoNE, 2012a). With this project, the Turkish Ministry of National Education (MoNE) aims to establish equal opportunity for every student to use and benefit from technology (Kayaduman, Sarıkaya, & Seferoğlu, 2011). To this end, public schools are planned to be provided with necessary technological equipment, such as tablet PCs, interactive whiteboards and

dynamic software by the year 2014 (Akgün, Yılmaz, & Seferoğlu, 2011). Another aim of this project is to increase students' achievement in international platforms by teaching them how to use and analyze real-life data with the help of technology (Çelen, Çevik, & Seferoğlu, 2011).

FATİH Project consists of five main components. First of all, some hardware and software systems have been developed in order to maintain a basis for technology. After the development of these systems, as a second step the Ministry of National Education provided educational provision and management to ensure the success of the project. Next, the MoNE began to make some changes in the curriculum. They have integrated the use of technology into curriculum in order to ensure that all students use or utilize technology actively in lessons. Teachers have been educated about how to integrate this technology into their instructional process by attending workshops and professional development sessions (MoNE, 2012a). Finally, an information technology utilization system has been designed to be used by schools across the country. Moreover, within the framework of this project, tablet PCs are prepared to be distributed to all students and teachers in public schools in Turkey (MoNE, 2012a).

## Teacher education and technology in Turkey

As it will not be enough to provide schools with the necessary technological educational tools, research studies have begun to be conducted in order to learn more about Turkish teachers' views about integrating this technology into their instructional process (Yüksel & Alemdar, 2012). According to Erbaş (2005), mathematics can be learned more easily by enabling students to see multiple

representations of the problems with the help of technological tools. Similarly, Ersoy (2003) reports that using technology, specifically computers and calculators, in instruction enable students to think critically and encourage them to solve problems. Because teachers are one of the key factors and change agents in the process of integrating technology into schools, learning about their knowledge and experience with this technology has become an important issue.

Teachers are one of the most important elements of teaching and learning process (Çatma, 2013; NCTM, 2000). Since it is teachers who are mainly responsible for students' learning, it is of great importance to improve their qualifications through education programs in order to ensure high standards of excellence in education (Tarman, 2010).

In Turkey, the major change in teacher education started in 1981 with programs conducted by universities (Çakıroğlu & Çakıroğlu, 2003). In the year 1989, the Turkish Higher Education Council decided that people who would like to become teachers must attend education faculties and have a teaching certificate (Gürşimşek, Kaptan, & Erkan, 1997). Based on the decision of the Higher Education Council, many education faculties were established in Turkey in order to train teachers with high teaching qualifications and skills.

The rapid innovations and developments in technology have made it difficult for teachers to make use of technological devices and tools in their teaching and learning processes. Because most educators agreed on the benefits of using technology during instruction, it becomes a necessity for teachers to use technology during instruction

(Aydın, 2003). Therefore, teachers should also be trained about how to use technology effectively as an instructional tool in teaching and learning processes (Koehler & Mishra, 2009). In view of this need, the Turkish Ministry of National Education firstly introduced technological educational tools, such as computers and projectors (Akbaba-Altun, 2006). In 2010, with FATİH Project, the Turkish Ministry of Education made a huge movement in order to spread the use of technology all over the country (Gürol, Donmuş, & Arslan, 2012; MoNE, 2012a).

Teachers' knowledge of and experience with technology is of utmost importance as they are the leaders in the provision of these changes in education. In recent research studies, it was revealed that many Turkish teachers have problems in learning how to use educational technological devices and tools (Akbaba-Altun, 2006; Kocasaraç, 2003). According to Kocasaraç (2003), Turkish teachers do not feel confident about learning about technological devices and using them in classrooms. Akbaba-Altun (2006) maintains that although Turkish teachers want to use technology during instruction, but they are afraid to use it simply because they lack the necessary experience. To overcome these problems, it is necessary to teach teachers how to use and integrate technology and thereby increase their technological pedagogical knowledge, The Turkish Higher Education Council made some changes in the curriculum of teacher education programs. In 1998 "instructional technology and material design" course was established as a compulsory course in all teacher education programs in Turkey (Gündüz & Odabaşı, 2004). With this course, the Higher Education Council aimed to establish an effective teaching and learning environment for students by teaching educators about how to use technological tools in the classroom.

## Summary

In this chapter, several research-based and theory-based articles were analyzed in order to present different perspectives to answer the research questions. This chapter began with the first theme: mathematics education and technology. This part aimed to give some general information about mathematics education with technology in Turkey and all over the world. The following part focused on calculators as a branch of technology. In this part, several research findings about the advantages and disadvantages of using calculators in mathematics instruction were analyzed as the present study aims to explore high school mathematics teachers' believes, attitudes and views about using digital technology, particularly calculators. This part also focused on in-service and pre-service mathematics teachers' ideas about using this technology in their classrooms. The third theme defined term "technological pedagogical content knowledge" and provided some explanation about its significance. In the fourth part, an important project that Turkey began to implement in order to spread the use of technology all over the country was defined. This project was related to the current research study because with this project Turkey aims to bring all classrooms technology. Therefore, it has become important to know about teachers' knowledge for how to use this technology. Finally, brief information about teacher education programs in Turkey was given. This part also emphasized how technology was used in these programs in order to improve teachers' knowledge about integrating technology in teaching and learning process.

# CHAPTER 3: METHOD

## Introduction

This research study aims to explore Turkish pre-service and in-service high school mathematics teachers' beliefs and views towards using digital technology, particularly calculators, in their mathematics classrooms. By identifying the differences between pre-service and in-service Turkish high school mathematics teachers' beliefs and views about using technology, it attempts to provide a wider perspective on the possible use of digital technology in Turkish classrooms.

The research questions of this study are as follows:

1. What beliefs and views do **in-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?
2. What beliefs and views do **pre-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?
3. Is there a statistically significant difference between pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?
4. Is there a statistically significant difference between female and male high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?
5. Is there a statistically significant difference between in-service private and public high school mathematics beliefs and views about using digital technology specifically calculators in mathematics classrooms?

6.Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education program from private universities and those from public universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms?

This chapter consists of six main parts, namely research design, context, sample/participants, instrumentation, data collection and data analysis procedure. The first part provides information about the type of research design used in the present study to find possible answers to the research questions. The second part provides information about where and when the study was conducted. The third part focuses on participant and the sampling strategy. This part also provides detailed information about the participant schools and universities, the participants' number, their age and gender distribution and teaching experience. The fourth part, titled instrumentation, is about the tool used in the present research in order to find possible answers to each research question. The fifth part focuses on data collection methods. The sixth and final part elaborates on how data were analyzed and reported for each research question.

## Research design

The primary research design was descriptive in nature. In a descriptive quantitative research design, the researcher's aim is to estimate participants' attitudes and make decisions on a subject by considering the participants' responses (Arghode, 2012; Creswell, 2013). As the current study mainly intended to find out and compare pre-service and in-service high school mathematics teachers' beliefs, attitudes and views about using digital technology, particularly calculators, in mathematics teaching and

learning process, a descriptive quantitative research design was used. A typical descriptive statistical analysis consists of computing statistics, such as mean, median, mode, variance, range, standard deviation, skewness, kurtosis and frequency tables. Furthermore, to get a deeper understanding of and between the groups, a comparison of mean ranks was conducted as well.

## Context

This study was conducted in two cities in Turkey: Ankara and İzmir. The pre-service mathematics teachers were chosen from both private and public universities. The pre-service teachers from these universities participated in this research study by responding to the online survey questions. The researcher firstly sent an e-mail to the pre-service high school mathematics teachers in order to introduce herself and explain the aim of the research study. After that, the researcher sent the pre-service teachers the link where they can find the survey questions by using Lime Survey in April 2013. Reminder e-mails were also sent in April and June 2013 in order to encourage the pre-service teachers to respond the survey questions.

The in-service high school mathematics teachers were chosen from the public and private high schools in Ankara. There were two private and three public high schools within the research study. In order to conduct the research study in these schools permission was requested from MoNE by the researcher. The researcher gave documents to the MoNE which requires the purpose of the present research study, problem statement, research questions, significance of the research study, review of the related literature, method of data collection, participant/sampling strategy, instrumentation and method of data analysis. After obtaining necessary permission

from the MoNE, the researcher began to conduct the research study in these high schools. The in-service high school mathematics teachers from these high schools participated in this study by responding to the same survey questions by using paper and pencil in November and December 2013.

## Sample/Participants

This research study was conducted with 31 pre-service and 29 in-service high school mathematics teachers from two different universities and five different high schools. All of the high-school in-service mathematics teachers were chosen from Ankara. The pre-service high school mathematics teachers were chosen from Ankara and İzmir. Public high schools were also chosen for this research study. The public high schools in this study were those which the researcher could receive permission from the Ministry of National Education in order to conduct the research study. Another reason for including public high schools for this study was to observe the similarities and differences in private and public high school in-service mathematics teachers' beliefs about the use of digital technology, particularly calculators, during mathematics instruction.

In a wider perspective, this research study tries to reach a better understanding of the possible use of technology in mathematics lessons and the progress that FATİH Project has made in Turkish classrooms. With this aim in mind, both pre-service and in-service high school mathematics teachers were chosen for this research study in order to find out whether there is a difference between their attitudes, beliefs and views about using digital technology, particularly calculators, in their classrooms.

Table 1 and table 2 present the response rates of participants for schools and universities sequentially.

Table 1
Response rate for high schools (the in-service teachers)

| | Number of total mathematics teachers | Respondent number | Response rate % |
|---|---|---|---|
| Private high schools (2 schools) | 20 | 12 | 60.00% |
| Public high schools (3 schools) | 21 | 17 | 80.95% |

Table 2
Response rate for universities (the pre-service teachers)

| | Number of total mathematics student teachers | Respondent number | Response rate % |
|---|---|---|---|
| Private University (First and second year students) | 21 | 18 | 85.72% |
| Public University | 20 | 13 | 65.00% |

Table 1 presents that, in-service high school mathematics teachers from public high schools participated to the research study with higher response rate than private high school mathematics teachers. On the other hand, Table 2 presents that pre-service high school mathematics teachers who receive their teacher education from private university participated to the research study with higher response rate than those from public university.

The principals of the participant high schools provided the necessary information to the researcher about the total number of mathematics teachers working at their schools. The researcher tried to reach all the mathematics teachers in order to

conduct the survey in those particular high schools. The researcher also tried to reach the pre-service high school mathematics teachers via e-mail. The researcher got the pre-service high school mathematics teachers e-mail addresses with the help of the lecturers from those universities. Both the pre-service and the in-service high school mathematics teachers who participated in the research work on a voluntary basis.

Table 3 and table 4 present the number of the pre-service and in-service teachers from the participant high schools and universities.

Table 3
The participant high schools and the number of the in-service teachers

| High school | Number of in-service teachers |
|---|---|
| X 1 | 6 |
| X 2 | 6 |
| Y 1 | 5 |
| Y 2 | 6 |
| Y 3 | 6 |
| Total | 29 |

*Note.* X stands for private high school. Y stands for public high school.

Table 4
The participant universities and the number of the pre-service teachers

| University | Number of pre-service teachers |
|---|---|
| Z | 18 |
| T | 13 |
| Total | 31 |

*Note.* Z stands for private university. T stands for public university.

Table 3 and table 4 present that out of 60 participants, there were 31 pre-service service and 29 in-service high school mathematics teachers from 2 different universities and 5 different high schools. The number of the pre-service and in-service high school mathematics teachers' was not equal.

Gender distribution of the participants is presented in Table 5 below.

Table 5
Gender distribution of the participants

| | Female | Male | Percentage | Total |
|---|---|---|---|---|
| Private high schools | 8 | 4 | 20.0% | 12 |
| Public high schools | 9 | 8 | 28.3% | 17 |
| Private university | 17 | 1 | 30.0% | 18 |
| Public university | 11 | 2 | 21.6% | 13 |
| Total | 45 | 15 | 100% | 60 |

Table 5 presents that 45 of 60 pre-service and in-service high school mathematics teachers were female while 15 of them were male. The number of the female participants and the male participants were not equal.

Age distribution of participants is presented in table 6.

Table 6
Age distribution of the participants

| | Age (year) | | | | |
|---|---|---|---|---|---|
| | 20-29 | 30-39 | 40-49 | 50-59 | Total |
| Private high schools | 1 | 8 | 4 | 0 | 13 |
| Public high schools | 0 | 3 | 11 | 2 | 16 |
| Private university | 18 | 0 | 0 | 0 | 18 |
| Public university | 13 | 0 | 0 | 0 | 13 |
| Total | 32 | 11 | 15 | 2 | 60 |

Table 6 presents that more than half of the in-service high school mathematics teachers were aged between 40 and 49. There were just one in-service high school mathematics teacher aged between 20 and 29 and there were just two in-service high school mathematics teachers were aged between 50 and59. Rest of the in-service high school mathematics teachers were aged between 30 and 39. On the other hand, all of the pre-service high school mathematics teachers were aged between 20 and 29.

Table 7 presents the teaching experience of the in-service high school mathematics teachers who agreed to participate in this research study.

Table 7
Teaching experience of the in-service participants

| | Years | | | |
|---|---|---|---|---|
| | 5-10 | 11-15 | 16-20 | 21-25 |
| Private high schools | 4 | 4 | 4 | 0 |
| Public high schools | 0 | 4 | 6 | 5 |
| Total | 4 | 9 | 10 | 5 |

Table 7 presents that 19 of 29 in-service high school mathematics teachers had more than 10 years of teaching experience. There were just 4 participants with less than 5 years of teaching experience. There was just one participant who did not answer the question about the teaching experience.

## Instrumentation

Surveys are effective ways to gather information from large numbers of participants in a certain period of time (Taylor & Bogdan, 1984). Moreover, surveys enable researchers to analyze and evaluate the data more easily, for they provide opportunity for researches to conduct statistical analysis. Because of all these reasons, a survey was used as an instrument to conduct this study (Appendix 1). The survey questions used for this research study were formed by Huang (1993). Those survey questions have been used in Fleneer's (1995) study before. Survey questions were chosen intentionally because they directly address the researcher's research questions in the present study. Also the survey questions were tested in terms of reliability and validity. The validity of the survey questions was tested by Bittler and Hatfield (1992). As in the Fleener's study, three categories were defined in order to find out teachers' beliefs, views and attitudes about using digital technology, particularly calculators, during mathematics instruction: (i) teachers' beliefs and views about the cognitive effects of using calculators, (ii) teachers' experience with and use of this technology, (iii) teachers' beliefs and views about the benefits of using calculators during mathematics instruction (Fleener, 1995, p.57). Cronbach's *alpha* was used in order to test the survey items reliability. Cronbach's *alpha* values were found as in the following for the three categories: category 1; .77, category 2; .75 and category 3; .83 respectively. Permission was requested from the author to use

these questions in the present study. In addition, the in-service and pre-service high school mathematics teachers' gender, age and service periods were also asked in order to have more information about the participants. Moreover, informal talks with participants were also considered while evaluation of the data.

There were 23 Likert-type questions in the survey. Point scales were determined as: 1=strongly agree, 2=agree, 3=disagree and 4=strongly disagree in the present research study. Table 8 presents the categories of the survey items.

Table 8
Categories of the survey questions and the item numbers

| | |
|---|---|
| Category 1 | Teachers' beliefs and views about the cognitive effects of using calculators. |
| | Item numbers: 1, 2, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 19 |
| Category 2 | Teachers' experience with and the use of calculators. |
| | Item numbers: 17, 18, 20, 21, 22, 23 |
| Category 3 | Teachers' beliefs and views about the benefits of using calculators during mathematics instruction. |
| | Item numbers: 3, 4, 7, 11 |

**Survey translation process**

The language of the survey was originally English. However, as participants of the current research study were from Turkey, the researcher translated the survey items into Turkish. The researcher followed some stages in the process of translation. First of all, the survey questions were translated into Turkish by the researcher. Then three teachers of English with master's degree translated the Turkish survey questions into English without seeing the original survey. Then, the researcher met the three

English teachers in March 2013 at Bilkent University. During the two-and-a half-hour meeting, the translations were compared with the original document by the researcher and the three teachers of English in order to make the final decision about the Turkish translation of the questions. In the meeting, all of the items were analyzed and discussed separately. On certain items the researcher and the English teachers spent more time in order to decide the most appropriate translation. The final decision on the items was made at the end of the meeting according to the researcher's and three English teachers' suggestions and comments in March 2013.

## Method of data collection

A pilot study was conducted with 11 first year and second year pre-service high school mathematics teachers from a private university in April 2013 in order to detect the possible problems and decide the final version of the survey questions.

After the analysis of the pilot study, the researcher decided to make some changes in two items of the survey. Because pre-service high school mathematics teachers were also involved in the current research study, the items, numbered 17 and 18 were changed as follows,

The item 17 was originally "I have calculators available for my class(es) to use". This item was changed into "It will be helpful for me to have calculators available for my class(es) to use".

The item 18 was originally "Most of my students have access to their own calculators". This item was changed into "I want my students to have access to their own calculators".

After making the necessary corrections, descriptive data were collected through survey method. The participants were informed via e-mail about the purpose of the study before they began to respond. It should also be noted that all the teachers who responded the survey questions participated in the study on a voluntary basis. The participants were all informed about the details of the research study beforehand. The pre-service high schools mathematics teachers participated in the survey via the Internet. Having received the necessary permission from the MoNE and the school principals to conduct the survey, the researcher collected the data about the in-service high school mathematics teachers in person on a voluntary basis.

The researcher waited for the in-service high school mathematics teachers to respond the survey questions at schools. There is confidentiality in this study that the researcher will not allow the answers to be seen by the other participants.

## Method of data analysis

Statistical Package for the Social Sciences (SPSS) 20.0 was used to analyze the descriptive data. As mentioned in the instrumentation section, there were 23 Likert-type questions in the survey. Point scale was determined as: 1=strongly agree, 2=agree, 3=disagree and 4=strongly disagree for each item. Firstly, all scores for each participant were calculated by using the point scale. Then, the percentage distribution of participants' responses to each item was analyzed through frequency tables.

Consensus items were used to find possible answers to the research questions 1 and 2. For each item, consensus items were defined as equal to or greater than 70% agreement or disagreement (Fleener, 1995, p.57). In order to explain the percentage

distributions of the in-service and pre-service high school mathematics teachers' responses, two sub-categories were defined as positive **A** and negative **B**. **A** defined as the sum of the percentages of the in-service/pre-service high school mathematics teachers' "strongly agree" and "agree" responses to each item. **B** defined as the sum of the percentages of the in-service high school mathematics teachers' "disagree" and "strongly disagree" responses to each item. After calculating the value of **A** and **B**, consensus items were determined as the value of **A** or **B** greater than or equal to 70.

Because the data were at ordinal level mean scores did not help the researcher to find the possible answers to the research questions 3, 4, 5 and 6. In order to analyze the mean rank scores of the groups, a non-parametric Mann Whitney *U* test was conducted in related research questions. Mann Whitney *U* test helped the researcher to reject or fail to reject the null hypothesis by comparing the mean rank scores between the two groups and to find out whether there is a statistically significant difference between the responses of the pre-service and in-service high school mathematics teachers (Nachar, 2008).

## Summary

This chapter consisted of six main parts in order to provide information about research design, context, sample/participants, instrumentation, data collection and data analysis for the current research study.

Detailed information about data analysis process and results shall be provided in chapter 4.

# CHAPTER 4: RESULTS

## Introduction

This chapter provides detailed information about the method and results of data analyses. In this chapter, each research question will be analyzed sequentially and results will be presented afterwards. Thus, this chapter consists of six main sections devoted to the analysis of each research question.

The first section provides detailed information about how the first research question was addressed and presents the results of the major findings. This section covers important findings about the in-service high school mathematics teachers' beliefs, attitudes and views about using calculators during mathematics instruction and summarizes some major findings through tables based on the three categories (See page 45 for the categories). The second section provides information about how the second research question was analyzed. This section also presents the results for each category sequentially in order to help the researcher to explain the pre-service high school mathematics teachers' attitudes towards using digital technology, particularly calculators, in mathematics classrooms. The third section provides detailed information about how the third research question was analyzed. It gives further information about non-parametric Mann Whitney *U* Test and presents the findings of the test in order to respond the third research question. The forth section is about gender differences on the same research question by performing a non-parametric Mann Whitney *U* test. Finally the fifth and the sixth sections elaborate on the major findings like the differences and similarities between the views of the in-service

private and public high school mathematics teachers and between the pre-service high school mathematics teachers who received their teacher education from private universities and those from public universities.

To answer the research questions, all the items in the survey were analyzed separately in three categories. The three categories were adapted from Fleener's research study (Fleener, 1995, p.57). Table 9 shows the three categories and the item numbers of the survey questions below.

Table 9
Categories and related item numbers

| | |
|---|---|
| Category 1 | Teachers' beliefs and views about cognitive effects of using calculators.<br>Item numbers: 1, 2, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 19 |
| Category 2 | Teachers' experience with and use of calculators.<br>Item numbers: 17, 18, 20, 21, 22, 23 |
| Category 3 | Teachers' beliefs and views about the benefits of using calculators during mathematics instruction.<br>Item numbers: 3, 4, 7, 11 |

To analyze the research questions 1 and 2, consensus responses were used. "For each category, consensus items were defined as equal to or greater than 70% agreement or disagreement" (Fleener, 1995, p.57).

## The results of the research question 1

The first research question was "What beliefs and views do **in-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?" To explain the first research question, the percentages of the in-service

high school mathematics teachers' responses were found by using frequency tables. All the items were analyzed separately in three categories. After that, consensus responses were used in order to determine the results for each item. For each category, consensus items were defined as equal to or greater than 70% agreement or disagreement (Fleener, 1995, p.57).

Table 10 presents the percentages of the in-service high school mathematics teachers' responses on category 1.

Category 1: Teachers' beliefs and views about the cognitive effects of using calculators.

Table 10
The in-service high school mathematics teachers' response on category 1

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 1. Students should not be allowed to use a calculator while taking mathematics exam. | 10.3 | 48.3 | 20.7 | 17.2 |
| 2. Calculator use will cause a decline in basic arithmetic facts. | 27.6 | 37.9 | 24.1 | 6.9 |
| 5. When students work with calculators, they do not need to show their work on paper. | 6.9 | 41.4 | 34.5 | 17.2 |
| 6. Mathematics is easier if a calculator is used to solve problems. | 10.3 | 37.9 | 37.9 | 13.8 |
| 8. Students understand mathematics better if they solve problems using paper and pencil. | **34.5** | **44.8** | 17.2 | 3.4 |
| 9. Students should not be allowed to use calculators until they have mastered the concept or procedure. | **34.5** | **51.7** | 10.3 | 3.4 |
| 10. All students should learn to use calculators. | **34.5** | **51.7** | 10.3 | 3.4 |
| 12. Calculators should be used only to check work once the problem has been worked out on paper. | 6.9 | 48.3 | 31.0 | 13.8 |
| 13. Calculators should be used in mathematics homework. | 0.0 | 48.8 | 37.9 | 13.8 |
| 14. Using calculators will cause students to lose basic computational skills. | 20.7 | 37.9 | 37.9 | 3.4 |
| 15. Using calculators make students better problem solvers. | 0.0 | 24.1 | **58.6** | **17.2** |
| 16. Continued use of calculators will cause a decrease in student estimation skills. | 31.0 | 31.0 | 34.5 | 3.4 |
| 19. Calculators are only tools for doing calculations more quickly. | **24.1** | **48.3** | 24.1 | 3.4 |

*Not*e. S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree.

In order to explain the table, two sub-categories were labelled as positive **A** and negative **B**. **A** defined as the sum of the percentages of the in-service high school mathematics teachers' "strongly agree" and "agree" responses to each item. **B**

defined as the sum of the percentages of the in-service high school mathematics teachers' "disagree" and "strongly disagree" responses to each item.

Following the calculation of the value of **A** and **B** for each item, consensus responses were used in order to determine the results of the survey. For each category, consensus items were defined as equal to or greater than 70% **A** or **B;** in other words, as "positive" or "negative" (Fleener, 1995, p.57).

For example, for item 1, **A** equals to 10.3%+48.3%= 58.6% and **B** equals to 20.7%+17.2%= 37.9%. According to Fleener (1995), because none of **A** and **B** values were equal to or greater than 70%, item 1 will not be considered as a consensus item.

By looking at the table 10, the results can be presented as:

The in-service high school mathematics teachers agreed on the following items about the cognitive effects of using calculators in mathematics instruction:

Item 8: Students understand mathematics better if they solve problems using paper and pencil (**A**=79.3%, **A**>70%).

Item 9: Students should not be allowed to use calculators until they have mastered the concept or procedure (**A**=86.2%, **A**>70%).

Item 10: All students should learn how to use calculators (**A**=86.2%, **A**>70%).

Item 19: Calculators are only tools for doing calculations more quickly (**A**=72.4%, **A**>70%).

The in-service high school mathematics teachers disagreed on the following item about the cognitive effects of using calculators in mathematics instruction:
Item 15: Using calculators make students better problem solvers (**B**=75.8%, **B**>70%).

According to table 10, even though the majority of the in-service high school mathematics teachers (**A**=86.2%) agreed that all students should learn how to use calculators, they have some concerns. Most of the in-service high school mathematics teachers (**A**=79.3%) stated that students should first learn how to solve mathematics problems by using pencil and paper. Moreover, they also argued that students should not be allowed to use calculators before they learn how to solve the questions by using traditional methods. Furthermore, most of the in-service high school mathematics teachers (**A**=72.4%) agreed that calculators are the only tools that can be used to do calculations more quickly during mathematics lessons.

Table 10 also presents that none of the in-service high school mathematics teachers strongly agreed with the items 13 and 15 (See table 10). Most of the in-service high school mathematics teachers (**B**=75.8%) do not believe that students will be better problem solvers with the help of calculators. However, nearly half of the in-service high school mathematics teachers (**A**=48.8%) agreed that students should be allowed to use calculators while they are doing their homework. More than half of the in-service high school mathematics (**A**=58.6%) teachers agreed that students should not use calculators during mathematics exams. Because most of the in-service high school mathematics teachers (**A**=58.6%) believe that using calculator will make the students to lose their computational skills, they (**A**=55.2%) indicated that students

should be allowed to use calculators to check their work after they have solved the problems in traditional ways.

Consensus items were used in order to analyze the in-service high school mathematics teachers' responses on category 2: "teachers' experience with and use of calculators". Sub-categories **A** and **B** were determined as sum of the percentages of the in-service high school mathematics teachers' "strongly agree" ,"agree" and "disagree", "strongly disagree" responses sequentially. After that, items which had equal to or over 70% A or B were used as results of the survey (Fleener, 1995).

Category 2: Teachers' experience with and use of calculators.

Table 11
The in-service high school mathematics teachers' response on category 2

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 17. It will be helpful for me to have calculators to use in my class(es). | 7.1 | 42.9 | 35.7 | 14.3 |
| 18. I want my students to have their own calculators. | 10.3 | 48.3 | 34.5 | 6.9 |
| 20. I have used graphing calculators during my education. | 10.3 | 37.9 | 24.1 | 24.1 |
| 21. I am proficient at using scientific calculators. | 10.3 | 37.9 | 37.9 | 13.8 |
| 22. I know ways I can use calculators effectively in my class(es). | 6.9 | 55.2 | 37.9 | 0.0 |
| 23. I have lots of ideas about how I can make use of this calculator. | 13.8 | 48.3 | 34.5 | 3.4 |

*Note.* S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree.

Table 11 presents that although none of the **A** or **B** values were greater than or equal to 70% for each item, in item 22 (**A**=62.1%) and item 23 (**A**=62.1%), A values were

closer to 70%. Thus, it can be interpreted that the in-service high school mathematics teachers were closer to have an agreement that they know the ways that they use calculators effectively during mathematics instruction. Also in item 17, the value of **A** (**A**=50%) and the value of **B** (**B**=50%) were equal. Thus, while 50% of the in-service high school mathematics teachers agreed that it would be helpful for them to have calculators in their classrooms, the other 50% disagreed. In item 20, while nearly half of the in-service high school mathematics teachers (**A**=48.2%) agreed that they have used graphing calculators during their education, **B**=48.2% of them disagreed. 3.6% of the in-service high school mathematics teachers did not want to answer item 20. Another remarkable response was on item 21. From table 11 it can be interpreted for item 21, while the in-service high school mathematics teachers (**A**=48.3%) agreed that they were proficient about using scientific calculators, the rest (**B**=51.7%) disagreed.

Consensus items were used in order to analyze the in-service high school mathematics teachers' responses on category 3: Teachers' beliefs and views about the benefits of using calculators during mathematics instruction. Sub-categories **A** and **B** were determined as sum of the percentages of the in-service high school mathematics teachers' "strongly agree" ,"agree" and "disagree", "strongly disagree" responses sequentially. Then items which have greater than or equal to 70% **A** or **B** were used as results of the survey.

Category 3: Teachers' beliefs and views about the benefits of using calculators during mathematics.

Table 12
The in-service high school mathematics teachers' response on category 3

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 3. Calculators are motivational. | 3.4 | 37.9 | 41.4 | 13.8 |
| 4. Calculators make mathematics fun. | 10.7 | 39.3 | 39.3 | 10.7 |
| 7. More interesting mathematics problems can be done when students have access to calculators. | **13.8** | **58.6** | 20.7 | 3.4 |
| 11. Using calculators will make students try harder. | 6.9 | 10.3 | **58.6** | **24.1** |

*Note.* S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree.

Table 12 shows that the in-service high school mathematics teachers agreed on the following item:

Item 7: More interesting mathematics problems can be done when students have access to calculators (**A**=72.4%, **A**>70%).

The in-service high school mathematics teachers disagreed on the following item from category 3:

Item 11: Using calculators will make students try harder (**B**=82.7%, **B**>70%).

Table 12 also shows that, more than half of the in-service high school mathematics teachers (**A**=55.2%) believe that calculators do not motivate students to learn. They mainly believe that using calculators will not make students more involved in the mathematics lessons. Moreover, according to Table 12, while 50% of the in-service high school mathematics teachers agreed that using calculator makes mathematics more enjoyable, 50% of them did not agree.

The results show that although the majority of the in-service high school mathematics teachers believe that students should learn how to use calculators, **A**=86.2% of them agreed that students should first learn how to solve mathematics problems in traditional methods by using paper and pencil. Most of the in-service high school mathematics teachers (**A**=73%) strongly believe that they can solve more challenging and interesting mathematics problems if they use calculators during mathematics instruction. Furthermore, during the informal talks with the researcher some of the in-service high school reported that using calculators enables teachers to save time and ask harder mathematics problems. However, the results revealed that the majority of the in-service mathematics teachers (**B**=82.7%) do not believe that calculators will make the students to solve harder mathematics problems or try harder.

### The results of the research question 2

The second research question was "What beliefs and views do **pre-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?" To answer the second research question, all the items on the survey were analyzed separately in three categories. The percentages of the pre-service high school mathematics teachers' responses were determined through frequency tables. Then consensus responses were used in order to determine the results for each item. For each category, consensus items were defined as greater than or equal to 70% agreement or disagreement (Fleener, 1995).

Table 13 presents the findings for the pre-service high school mathematics teachers' responses at item level for category 1.

Table 13
The pre-service high school mathematics teachers' response on category 1

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 1. Students should not be allowed to use a calculator while taking mathematics exam. | 12.9 | 27.6 | 48.4 | 16.1 |
| 2. Calculator use will cause a decline in basic arithmetic facts. | 16.1 | 38.7 | 38.7 | 6.5 |
| 5. When students work with calculators, they do not need to show their work on paper. | 9.7 | 19.4 | **32.3** | **38.7** |
| 6. Mathematics is easier if a calculator is used to solve problems. | 19.4 | 48.4 | 19.4 | 12.9 |
| 8. Students understand mathematics better if they solve problems using paper and pencil. | 22.6 | 29.0 | 48.4 | 0.0 |
| 9. Students should not be allowed to use calculators until they have mastered the concept or procedure. | 29.0 | 38.7 | 25.8 | 6.5 |
| 10. All students should learn to use calculators. | **48.4** | **45.2** | 6.5 | 0.0 |
| 12. Calculators should be used only to check work once the problem has been worked out on paper. | 9.7 | 29.0 | 54.8 | 6.5 |
| 13. Calculators should be used in mathematics homework. | **19.4** | **54.8** | 25.8 | 0.0 |
| 14. Using calculators will cause students to lose basic computational skills. | 6.5 | 32.3 | 48.4 | 12.9 |
| 15. Using calculators make students better problem solvers. | 6.5 | 38.7 | 41.9 | 12.9 |
| 16. Continued use of calculators will cause a decrease in student estimation skills. | 12.9 | 45.2 | 41.9 | 0.0 |
| 19: Calculators are only tools for doing calculations more quickly. | 22.6 | 35.5 | 25.8 | 16.1 |

*Note*. S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree.

In order to explain the table, two sub-categories were defined as positive **A** and negative **B**. **A** defined as the sum of the percentages of the pre-service high school mathematics teachers' "strongly agree" and "agree" responses to each item. **B**

defined as the sum of the percentages of the in-service high school mathematics teachers' "disagree" and "strongly disagree" responses to each item.

Following the calculation of the value of **A** and **B** for each item, consensus responses were used in order to determine the results of the survey. For each category, consensus items were defined as greater than or equal to 70% **A** or **B;** in other words, as "positive" or "negative" (Fleener, 1995).

For example, for item 1, **A** value equals to 12.9%+27.6%=40.5% and **B** value equals to 48.4%+16.1%=64.5%. Because none of the **A** or **B** values was greater than 70%, item 1 will not be considered as a consensus item for this research study.
After calculating **A** and **B** values for each item, the results can be presented as:

The pre-service high school mathematics teachers agreed on the following items about the cognitive effects of using calculators in mathematics instruction:
Item 10: All students should learn how to use calculators (**A**=93.6%, **A**>70%).
Item 13: Calculators should be used in mathematics homework (**A**=74.2%, **A**>70%).

The pre-service high school mathematics teachers disagreed on the following item about the cognitive effects of using calculators in mathematics instruction:
Item 5. When students work with calculators, they do not need to show their work on paper (**B**=71.0%, **B**>70%).
Table 13 also presents some other remarkable results. First of all, more than half of the pre-service high school mathematics teachers (**B**=64.5%) disagreed that students should not be allowed to use calculators while they are taking mathematics exam.

They (**A**=74.2%) believe that students should be allowed to use calculators while doing their homework. More than half of the pre-service mathematics teachers (**A**=67.8%) agreed that using calculators make mathematics problems easier to solve. However, the pre-service high school mathematics teachers (**B**=54.8%) disagreed that using calculators will make students better problem solvers. The pre-service high school mathematics teachers (**B**=54.8%) disagreed with the item about the relationship between calculators and students' basic computational skills. The pre-service high school mathematics teachers argue that using calculators will not make students lose their computational skills.

Consensus items were used in order to explain pre-service high school mathematics teachers' responses on category 2: teachers' experience with and use of calculators. Sub-categories **A** and **B** were determined as sum of the percentages of the pre-service high school mathematics teachers' "strongly agree" ,"agree" and "disagree", "strongly disagree" responses sequentially. Then items which have equal to or greater than 70% **A** or **B** were used as the results of the survey.

Category 2: Teachers' experience with and use calculators.

Table 14
The pre-service high school mathematics teachers' response on category 2

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 17. It will be helpful for me to have calculators to use in my class(es). | **29.0** | **41.9** | 19.4 | 9.7 |
| 18. I want my students to have their own calculators. | **29.0** | **51.6** | 6.5 | 12.9 |
| 20. I have used graphing calculators during my education. | 12.9 | 22.6 | 32.3 | 32.3 |
| 21. I am proficient at using scientific calculators. | 19.4 | 38.7 | 29.0 | 12.9 |
| 22. I know ways I can use calculators effectively in my class(es). | **25.8** | **48.4** | 22.6 | 3.2 |
| 23. I have lots of ideas about how I can make use of this calculator. | 25.8 | 41.9 | 29.0 | 3.2 |

*Note.* S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree

By looking at the table 14 results can be presented as:

The pre-service high school mathematics teachers agreed on the items about

Category 2: teachers' experience with and use of calculators,

Item 17: It will be helpful for me to have calculators to use in my class(es)

(**A**=70.9%, **A**>70%).

Item 18: I want my students to have their own calculators (**A**=80.6%, **A**>70%).

Item 22: I know ways I can use calculators effectively in my class(es) (**A**=74.2%,

**A**>70%).

Table 14 also shows that although more than half of the pre-service high school mathematics teachers (**B**=64.6%) declared that they did not use calculators during their own schooling, they (**A**=67.7%) agreed that they have ideas about the effective ways to use calculators in classrooms during mathematics instruction. Moreover,

although they declared they did not use calculators during their education, more than 50% of the pre-service high school mathematics teachers indicated that they are capable of using scientific calculators effectively.

Consensus items were used in order to explain the pre-service high school mathematics teachers' responses on category 3: teachers' beliefs and views about the benefits of using calculators during mathematics. Sub-categories **A** and **B** were determined as sum of the percentages of the pre-service high school mathematics teachers' "strongly agree" ,"agree" and "disagree", "strongly disagree" responses sequentially. Then items which have equal to or greater than 70% **A** or **B** were used as results of the survey.

Category 3: Teachers' beliefs and views about the benefits of using calculators during mathematics.

Table 15
The pre-service high school mathematics teachers' response on category 3

| Item | S.A % | A % | D % | S.D % |
|---|---|---|---|---|
| 3. Calculators are motivational. | 19.4 | 48.4 | 25.8 | 6.5 |
| 4. Calculators make mathematics fun. | 25.8 | 41.9 | 22.6 | 9.7 |
| 7. More interesting mathematics problems can be done when students have access to calculators. | **35.5** | **41.9** | 19.4 | 3.2 |
| 11. Using calculators will make students try harder. | 9.7 | 35.5 | 41.9 | 12.9 |

*Note.* S.A: Strongly Agree, A: Agree, D: Disagree, S.D: Strongly Disagree

After calculating **A** and **B** values for each item, the results can be presented as:

The pre-service high school mathematics teachers agreed on the following item about their beliefs and views about the benefits of using calculators during mathematics instruction:

Item 7: More interesting mathematics problems can be done when students have access to calculators (**A**=77.4%, **A**>70%).

Table 15 also shows that in item 3 (**A**=67.8%) and 4 (**A**=67.7%) A values were closer to 70%. Hence, it can be interpreted that the pre-service high school mathematics teachers believe that by using calculators mathematics can be more enjoyable for the students. While talking with the researcher, some of the pre-service participants informally indicated that because calculators are hands on, using calculators will make students involved in mathematics lessons more easily. However, 54.8% of the pre-service high school mathematics teachers responded that they do not believe the use of calculators will make students try harder during mathematics lessons.

The results show that nearly all of the pre-service high school mathematics teachers (**A**=93.6%) believe that all students should learn how to use calculators. Moreover, the majority of the pre-service high school mathematics teachers (**A**=80.6%) want their students to have their own calculators and want them to bring calculators to classrooms for mathematics lessons. Most of the pre-service high school mathematics teachers also indicated that they know how to use calculators effectively (**A**=77.4%) during mathematics instruction and moreover, they believe with the help of calculators they can ask more interesting and challenging mathematics problems to students (**A**=74.2%). However, like the in-service high

school mathematics teachers, the pre-service high school mathematics teachers agreed that students need to show their work on paper even when they solve mathematics questions with the help of calculators.

**The results of the in-service and pre-service high school mathematics teachers' responses**

Table 16 and table 17 summarize the item numbers that the in-service and pre-service high school mathematics teachers had equal to or greater than 70% agreement or disagreement.

Table 16
Items that the in-service high school mathematics teachers agreed or disagreed

| | Category 1 | Category 2 | Category 3 |
|---|---|---|---|
| Item Number A | 8, 9, 10, 19 | - | 7 |
| Item Number B | 15 | - | 11 |

*Note.* A stands for equal to or greater than 70% agreement. B stands for equal to or greater than 70% disagreement.

Table 17
Items that the pre-service high school mathematics teachers agreed or disagreed

| | Category 1 | Category 2 | Category 3 |
|---|---|---|---|
| Item Number A | 10,13 | 17, 18, 22 | 7 |
| Item Number B | 5 | - | - |

*Note.* A stands for equal to or greater than 70% agreement. B stands for equal to or greater than 70% disagreement.

After the analysis of the first and second research questions, the results show that the responses of the in-service and the pre-service high school mathematics teachers' responses to item 10 from category 1 and item 7 from category 3 were common. It can therefore be interpreted that the in-service and pre-service high school mathematics teachers want all students to learn how to use calculators and moreover, they believe that with the appropriate use of calculators, more interesting and challenging mathematics problems can be done during mathematics instruction.

## The results of the research question 3

The third research question of the present study was "Is there a statistically significant difference between the high school pre-service and the in-service mathematics teachers' beliefs, attitudes and views about using digital technology, particularly calculators in mathematics classrooms?" Because the data were at ordinal level, in order to analyze the items a non-parametric Mann Whitney *U* test was conducted. Mann Whitney *U* test helped the researcher to reject or fail to reject the null hypothesis by comparing the mean ranks between the two groups and to find out whether there is a statistically significant difference between the responses of the pre-service and in-service high school mathematics teachers (Nachar, 2008).

There were 23 Likert type questions in the survey. To calculate the total scores, point scale was used as in the following: 1=strongly agree, 2=agree, 3=disagree, 4= strongly disagree for each item.

Table 18 presents the results of Mann Whitney *U* test for the in-service and pre-service high school mathematics teachers' total scores.

Table 18
Mann Whitney *U* test 1 results for the participants' total scores

| Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|
| **273.00** | **-2.62** | **.01** |

According to Mann Whitney *U* test result for the in-service and pre-service high school mathematics teachers' total scores, the asymptotic significance value was smaller than the pre-specified alpha value, which is .05. Thus, the researcher rejected the null hypothesis. Test results presented that there was a statistically significant difference between the mean ranks of the total scores of the in-service and pre-service high school mathematics teachers' responses.

Table 19 presents descriptive statistics findings for the Mann Whitney U test results.

Table 19
Mann Whitney *U* test 1 descriptive statistics

| Type | Number | Mean Rank | Sum of Ranks |
|---|---|---|---|
| In-service | 29 | 36.59 | 1061.00 |
| Pre-service | 31 | 24.81 | 769.00 |
| Total | 60 | | |

Table 19 presents that, the mean ranks for the total scores of the in-service high school mathematics teachers' were significantly higher than the pre-service high school mathematics teachers' mean rank scores. That means, when participants' total

scores were ranked from highest to lowest, the mean of the ranks for in-service high school mathematics teachers scores were statistically significant higher than pre-service high school mathematics teachers'.

Table 20 presents the findings of Mann Whitney *U* test results for the in-service and pre-service high school mathematics teachers' total scores for each category (See page 45 for categories)

Table 20
Mann Whitney *U* test results for each category

| Category | Mann Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| Category 1 | 364.50 | -1.06 | .29 |
| Category 2 | 333.50 | -1.33 | .18 |
| Category 3 | **282.00** | **-2.15** | **.03** |

According to table 20, the asymptotic significance values for category 1 and 2 were greater than the pre-specified alpha value (.05). Thus, for category 1 and 2 there was no statistically significant difference between the mean ranks of the in-service and pre-service high school mathematics teachers' responses. However, for category 3, the asymptotic significance value was smaller than the pre-specified alpha value alpha value, which is .05. Thus, for category 3, there was a statistically significant difference between the mean ranks of the total scores of the in-service and pre-service high school mathematics teachers' responses. For category 3, the mean ranks for total scores of the in-service high school mathematics teachers' were significantly higher than the pre-service high school mathematics teachers' mean rank scores.

Table 21 presents the results of Mann Whitney *U* test for each item.

Table 21
Mann Whitney *U* test results for each item

| Item | Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| 1 | 364.50 | -1.11 | .27 |
| 2 | 362.00 | -1.15 | .25 |
| **3** | **296.50** | **-2.23** | **.03** |
| 4 | 338.50 | -1.53 | .13 |
| 5 | 340.00 | -1.83 | .07 |
| 6 | 361.50 | -1.38 | .17 |
| 7 | 356.00 | -1.29 | .19 |
| 8 | 333.00 | -1.83 | .07 |
| 9 | 375.00 | -1.18 | .24 |
| 10 | 373.00 | -1.25 | .21 |
| **11** | **319.00** | **-2.09** | **.04** |
| 12 | 412.50 | -.59 | .56 |
| **13** | **258.50** | **-2.92** | **.00** |
| 14 | 326.50 | -1.95 | .05 |
| 15 | 349.50 | -1.61 | .11 |
| 16 | 393.00 | -.89 | .38 |
| **17** | **305.00** | **-2.07** | **.04** |
| 18 | 329.50 | -1.92 | .06 |
| 19 | 382.00 | -1.05 | .29 |
| 20 | 382.50 | -.82 | .42 |
| 21 | 394.50 | -.86 | .39 |
| 22 | 351.50 | -1.59 | .11 |
| 23 | 394.50 | -.87 | .38 |

Table 21 presents that there were a statistically significant difference between the mean ranks of the two groups. In items 3, 11, 13 and 17, the asymptotic significance values were smaller than the pre-specified alpha value, which is .05. Thus, for items 3, 11, 13 and 17, the researcher rejected the null hypothesis.

The results show that statistically significant differences were found from each category. Item 13 belongs to the category 1: teachers' beliefs and views about the cognitive effects of using calculators. Item 17 belongs to the category 2: teachers' experience with and use of calculators and item 3 and item 11 belong to the category 3: teachers' attitudes about the benefits of using calculators during mathematics instruction.

Category 1: Teachers' beliefs and views about the cognitive effects of using calculators.

Item 13: Calculators should be used on mathematics homework ($z=-2.92$, $p<.05$).

Category 2: Teachers' experience with and use of calculators.

Item 17: It will be helpful for me to have calculators to use in my class(es) ($z=-2.07$ $p=.04$).

Category 3: Teachers' attitudes about the benefits of using calculators during mathematics instruction.

Item 3: Calculators motivates students to learn ($z=-2.23$, $p=.03$).

Item 11: Using calculators will make students try harder ($z=-2.09$, $p=.04$).

**The results of the research question 4**

The fourth research question of the current study was "Is there a statistically significant difference between female and male mathematics teachers' beliefs, attitudes and views about using digital technology specifically calculators in mathematics classrooms?" Because the data were at ordinal level, a non-parametric Mann Whitney *U* test was conducted in order to analyze the items. Non-parametric Mann Whitney *U* test helped the researcher to reject or fail to reject the null hypothesis by comparing the mean ranks between the two groups and to find out whether there is a statistically significant difference between the responses of the male and female high school mathematics teachers (Nachar, 2008).

There were 23 Likert type questions in the survey. To calculate the total scores, point scale was used as in the following: 1=strongly agree, 2=agree, 3=disagree, 4= strongly disagree for each item.

Table 22 presents the results of Mann Whitney *U* test for female and male high school mathematics teachers' total scores.

Table 22
Mann Whitney *U* test results for the participants' total scores

| Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|
| 331.50 | -0.34 | .73 |

According to Mann Whitney *U* test result for female and male high school mathematics teachers' total scores, the asymptotic significance value was greater than the pre-specified alpha value, which is .05. Thus, the researcher failed to reject

the null hypothesis. There was no statistically significant difference between the mean ranks of the total scores of female and male high school mathematics teachers' responses.

Table 23 presents the findings of Mann Whitney *U* test results for female and male high school mathematics teachers' total scores for each category (See page 45 for categories)

Table 23
Mann Whitney *U* test results for each category

| Category | Mann Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| Category 1 | 322.50 | -0.37 | .71 |
| Category 2 | 288.00 | -0.62 | .54 |
| Category 3 | 309.50 | -0.47 | .64 |

According to table 23, the asymptotic significance values for category 1, category 2 and category 3 were greater than the pre-specified alpha value (.05). Thus, the researcher failed to reject the null hypothesis that for category 1, category 2 and category 3 there was no statistically significant difference between the mean ranks of female and male high school mathematics teachers' responses.

Table 24 presents the results of non-parametric Mann Whitney test for each item.

Table 24
Mann Whitney *U* test results for each item for female and male participants

| Item | Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| 1 | 332.50 | -0.21 | .84 |
| 2 | 316.50 | -0.50 | .62 |
| 3 | 332.00 | -0.22 | .83 |
| 4 | 333.00 | -0.20 | .84 |
| 5 | 348.50 | -0.06 | .95 |
| 6 | 348.50 | -0.06 | .95 |
| 7 | 311.00 | -0.61 | .54 |
| 8 | 327.50 | -0.44 | .66 |
| 9 | 347.00 | -0.09 | .93 |
| 10 | 281.00 | -1.32 | .19 |
| 11 | 324.00 | -0.51 | .62 |
| 12 | 291.00 | -.1.10 | .27 |
| 13 | 334.50 | -0.18 | .86 |
| 14 | 312.50 | -0.71 | .48 |
| 15 | 312.50 | -0.67 | .51 |
| 16 | 348.00 | -0.07 | .94 |
| 17 | 327.00 | -0.56 | .96 |
| 18 | 334.00 | -0.33 | .75 |
| 19 | 337.50 | -0.26 | .80 |
| 20 | 281.00 | -1.12 | .26 |
| 21 | 273.50 | -1.38 | .17 |
| 22 | 318.00 | -0.63 | .53 |
| 23 | 337.50 | -0.26 | .80 |

Table 24 presents that there was no statistically significant difference between the mean ranks of female and male high school mathematics teachers' responses for each item. For each item, the asymptotic significance values were greater than the pre-specified alpha value, which is .05. Therefore, for this research question the researcher failed to reject the null hypothesis.

## The results of the research question 5

The fifth research question of the present study was "Is there a statistically significant difference between the in-service private school and public school high school mathematics teachers' beliefs, attitudes and views about using digital technology specifically calculators in mathematics classrooms?" Because the data were at ordinal level, a non-parametric Mann Whitney *U* test was conducted in order to analyze the items. Non-parametric Mann Whitney *U* test helped the researcher to reject or fail to reject the null hypothesis by comparing the mean ranks between the two groups and to find out whether there is a statistically significant difference between the responses of the in-service private and public high school mathematics teachers (Nachar, 2008).

There were 23 Likert type questions in the survey. To calculate the total scores, point scale was used as in the following: 1=strongly agree, 2=agree, 3=disagree, 4= strongly disagree for each item.

Table 25 presents the results of Mann Whitney *U* test for the in-service private and public school high school mathematics teachers' total scores.

Table 25
Mann Whitney *U* test results for the in-service high school mathematics teachers' total scores

| Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|
| 66.500 | -0.93 | .35 |

According to Mann Whitney *U* test result for the in-service private and public high school mathematics teachers' total scores, the asymptotic significance value was greater than the pre-specified alpha value, which is .05. Thus, the researcher failed to reject the null hypothesis that there was no statistically significant difference between the mean ranks of the total scores of in-service private and public high school mathematics teachers' responses.

Table 26 presents the findings of Mann Whitney U test results for the in-service private and public high school mathematics teachers' total scores for each category (See page 45 for categories).

Table 26
Mann Whitney *U* test results for each category

| Category | Mann Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| Category 1 | 71.500 | -0.45 | .65 |
| Category 2 | 53.000 | -1.08 | .28 |
| Category 3 | 72.500 | -0.14 | .89 |

According to table 25, the asymptotic significance values for category 1, category 2 and category 3 were greater than the pre-specified alpha value (.05). Thus, the researcher failed to reject the null hypothesis. Thus, for category 1, category 2 and

category 3 there was no statistically significant difference between the mean ranks of female and male high school mathematics teachers' responses.

The results of table 25 and table 26 summarize that there was no statistically significant difference between the mean ranks of the in-service private and public high school mathematics teachers' responses. Thus, the researcher failed to reject the null hypothesis for this research question. Because there was no statistically significant difference, data will not be analyzed at item level.

## The results of the research question 6

The sixth research question of the current study was "Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education from public universities and those from private universities in terms of their beliefs, attitudes and views about using digital technology specifically calculators in mathematics classrooms?" As the data were at ordinal level, a non-parametric Mann Whitney *U* test was conducted in order to analyze the items. Non-parametric Mann Whitney *U* test helped the researcher to reject or fail to reject the null hypothesis by comparing the mean ranks between the two groups and to find out whether there is a statistically significant difference between the responses of the pre-service high school mathematics teachers who received their teacher education program from private university and those from public university (Nachar, 2008).

There were 23 Likert type questions in the survey. To calculate the total scores, point scale was used as in the following: 1=strongly agree, 2=agree, 3=disagree, 4= strongly disagree for each item.

Table 27 presents the results of Mann Whitney U test for the pre-service private and public school high school mathematics teachers' total scores.

Table 27
Mann Whitney *U* test results for the participants' total scores

| Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|
| 99.000 | -0.61 | .54 |

According to Mann Whitney *U* test result for the pre-service high school mathematics teachers' who received their teacher education from private university and those from public university total scores, the asymptotic significance value was greater than the pre-specified alpha value which is .05. Thus, the researcher failed to reject the null hypothesis. There was no statistically significant difference between the mean ranks of the total scores of the pre-service high school mathematics teachers who received their teacher from private universities and those from public universities.

Table 28 presents the findings of Mann Whitney *U* test results for the pre-service high school mathematics teachers who received their teacher education from private and those from public universities (See page 45 for categories).

Table 28
Mann Whitney *U* test results for each category

| Category | Mann Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| **Category 1** | **59.500** | **-2.23** | **.03** |
| Category 2 | 100.00 | -0.57 | .57 |
| **Category 3** | **41.000** | **-2.80** | **.00** |

According to table 28, the asymptotic significance values for category 1 and category 3 were smaller than the pre-specified alpha value which is .05. Therefore, for category 1 and category 3, there was a statistically significant difference between the mean ranks of the responses of pre-service high school mathematics teachers who received their teacher from private universities and those from public universities. However, for category 2, because the asymptotic significance value was higher than the pre-specified alpha value (.05), there was no statistically significant difference between the mean ranks of the pre-service high school mathematics teachers who received their teacher education from private university and those from public university.

Table 29
Mann Whitney *U* test descriptive statistics for category 1

| Type | Number | Mean Rank | Sum of Ranks |
|---|---|---|---|
| Private University | 18 | 18.87 | 358.50 |
| Public University | 13 | 11.46 | 137.50 |
| Total | 31 | | |

For category 1, results show that when pre-service high school mathematics teachers' scores for category 1 ranked from highest to lowest, the mean ranks of the pre-service high school mathematics teachers who received their teacher training program from private university were significantly higher than those from public university.

Table 30
Mann Whitney *U* test descriptive statistics for category 3

| Type | Number | Mean Rank | Sum of Ranks |
|---|---|---|---|
| Private University | 18 | 12.16 | 231.00 |
| Public University | 13 | 22.08 | 265.00 |
| Total | 31 | | |

On the other hand, for category 3, results show that when pre-service high school mathematics teachers' scores for category 3 ranked from highest to lowest, the mean ranks of the pre-service high school mathematics teachers who received their teacher training program from public university were significantly higher than those from private university.

Table 31 presents the results of non-parametric Mann Whitney *U* test for each item.

Table 31
Mann Whitney *U* test results for each item for the pre-service participants

| Item | Mann-Whitney U | Z | Asymp. Sig. (2- tailed) |
|---|---|---|---|
| 1 | 83.000 | -1.35 | .18 |
| 2 | 70.500 | -1.88 | .06 |
| **3** | **36.000** | **-3.41** | **.00** |
| **4** | **67.000** | **-2.01** | **.04** |
| 5 | 102.50 | -0.49 | .62 |
| 6 | 86.500 | -1.20 | .23 |
| **7** | **41.500** | **-3.14** | **.00** |
| 8 | 70.000 | -1.93 | .05 |
| 9 | 80.500 | -1.43 | .15 |
| 10 | 86.000 | -1.27 | .20 |
| 11 | 71.500 | -1.84 | .07 |
| **12** | **45.000** | **-3.11** | **.00** |
| 13 | 86.500 | -1.24 | .22 |
| 14 | 94.000 | -0.88 | .38 |
| 15 | 74.500 | -1.72 | .09 |
| 16 | 82.500 | -1.40 | .16 |
| 17 | 90.500 | -1.01 | .31 |
| **18** | **67.000** | **-2.08** | **.04** |
| **19** | **42.000** | **-3.04** | **.00** |
| 20 | 68.000 | -1.95 | .05 |
| 21 | 76.500 | -1.60 | .11 |
| 22 | 112.50 | -0.07 | .95 |
| 23 | 81.500 | -1.40 | .16 |

Table 31 presents that there were a statistically significant difference between the mean ranks of the two groups. In items 3, 4, 7, 12, 18 and 19, the asymptotic significance values were smaller than the pre-specified alpha value, which is .05. For those items, the researcher rejected the null hypothesis. That is, there was a statistically significant difference between the responses of pre-service high school mathematics teachers who received their teacher training program from private university and those from public university.

The results present that statistically significant differences were found from each category. Item 18 belongs to the category 1: teachers' beliefs and views about cognitive effects of using calculators. Item 12 and item 19 belong to the category 2: teachers' experience with and use of calculators. Item 3, 4 and 7 belong to category 3: teachers' beliefs and views about the benefits of using calculators during mathematics instruction.

Category 1: Teachers' beliefs and views about the cognitive effects of using calculators.

Item 12: Calculators should be used only to check work once the problem has been worked out on paper ($z=-3.11$, $p<.05$).

Item 19: Calculators are the only tools for doing calculations more quickly ($z=-3.04$, $p<.05$).

Category 2: Teachers' experience with and use of calculators.

Item 18: I want my students to have their own calculators ($z=-2.08$, $p=.04$).

Category 3: Teachers' beliefs and views about the benefits of using calculators during mathematics instruction.

Item 3: Calculators are motivational ($z=-3.41$, $p<.05$).

Item 4: Calculators make mathematics fun ($z=-2.01$, $p=.04$).

Item 7: More interesting mathematics problems can be done when students have access to calculators ($z=3.14$, $p<.05$).

## Summary

This chapter consists of six sections; each related to the six the analysis of the research questions and its results. The first section provided detailed information about how the first research question was analyzed, and presented the results of the major findings. The second section provided information about how research question 2 was analyzed. The second section presented the results for each category sequentially in order to help the researcher to explain the similarities and differences in the pre-service high school mathematics teachers' attitudes towards using digital technology, particularly calculators in classrooms. The third section provided detailed information about how research question 3 was analyzed. This section also provided information about Mann Whitney *U* Test and presented the findings of the test in order to respond the third research question. The fourth section provided information about gender differences on the same research question by conducting a Mann Whitney *U* Test. The last section elaborated on the major findings about the present research study and reflected different and common views of the in-service private and public high school mathematics teachers and pre-service private and public high school mathematics teachers' responses on the same research questions

in order to gain a wider perspective about the possible uses of digital technology in Turkish mathematics classrooms.

The results of the data analyses and the major findings will be discussed in detailed in chapter 5.

# CHAPTER 5: DISCUSSION

## Introduction

### Overview of the study

This research study is intended to explore Turkish high school pre-service and in-service mathematics teachers' beliefs and views about using digital technology, particularly calculators, in their mathematics classrooms in order to provide some insights into the use of technology in Turkish mathematics classrooms. By exploring Turkish pre-service and in-service high school mathematics teachers' views and beliefs about using digital technology specifically calculators during mathematics instruction, this timely research study presented significantly important results to the MoNE, which began to implement a smart class project, known as FATİH Project.

The following research questions were identified in order to investigate Turkish pre-service and in-service high school mathematics teachers' beliefs, attitudes and views about using digital technology, specifically calculators, in mathematics teaching and learning process.

1. What beliefs and views do **in-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?
2. What beliefs and views do **pre-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms?"
3. Is there a statistically significant difference between pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms?

4. Is there a statistically significant difference between female and male high school mathematics teachers' (both pre-service and in-service) beliefs and views about using digital technology specifically calculators in mathematics classrooms?
5. Is there a statistically significant difference between in-service private and public high school mathematics beliefs and views about using digital technology specifically calculators in mathematics classrooms?
6. Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education from private universities and those from public universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms?

Data were collected from the pre-service teachers from two different universities who are still receiving their teacher education and in-service teachers from five different high schools in Turkey. 31 pre-service high school mathematics teachers and 29 in-service high school mathematics teachers participated in the research study. A survey was used in order to collect the data. In-service and pre-service high school mathematics teachers participated in this research study by responding to the same survey questions. The survey questions were taken from Fleener's (1995) research study and three categories were used in order to analyze the participants' responses.

In order to answer the first and the second research questions, certain consensus items were used (see page 42). First of all, the percentage distributions of the participants' responses were calculated with the help of frequency tables. Next, two sub-categories were labelled as positive **A** and negative **B** in order to explain the

tables. **A** is defined as the sum of the percentages of the in-service high school mathematics teachers' "strongly agree" and "agree" responses to each item. **B** is defined as the sum of the percentages of the in-service high school mathematics teachers' "disagree" and "strongly disagree" responses to each item. After calculating the value of **A** and **B** for each item, consensus responses were used in order to determine the results of the survey. For each category, consensus items were defined as equal to or greater than 70% **A** or **B**, or more precisely as 'positive' or 'negative' (Fleener, 1995, p.57).

A null hypothesis and the alternative hypotheses were identified in order to answer the other four research questions. The Mann Whitney *U* Test was conducted for those research questions. Then by looking at the results of the test, the researcher compared the asymptotic significant values with a pre-determined alpha value of .05 and decided whether or not there was a statistically significant difference between the responses of the two groups (the pre-service and in-service high school mathematics teachers, female-male high school mathematics teachers, private-public high school mathematics teachers and pre-service high school mathematics teachers who received their teacher education from private and those from public universities).

In this chapter, the results obtained from the data analysis will be discussed critically in the light of the related literature. This chapter will also provide information about the future implications of the research study and its limitations.

## Major Findings

### Common points between the responses of pre-service and in-service teachers

It has been validated by several research studies that teachers' attitudes and believes about the usefulness of a teaching method or tool, affect their future use of that teaching method or tool in their classrooms (Ball, Lubienski, & Mewborn, 2001; Özgün-Koca, 2009). The findings and results obtained from the present research study showed that there are certain similarities and differences in pre-service and in-service Turkish high school mathematics teachers' views, attitudes and believes regarding the use of digital technology, calculators in particular. The results indicated that nearly all of the pre-service and in-service high school mathematics teachers (90%) agreed that "all students should learn how to use calculators" during mathematics instruction. This result was compatible with the Fleener's (1995) findings. According to Fleener's (1995) findings, 97% of the mathematics teachers agreed that "all students should learn how to use calculators". This finding is also in line with Göğüş's (2008) claim that many mathematics teachers know the advantages of using calculators and want their students to use calculators in mathematics teaching and learning process. In Doerr and Zangor's (2000) research study, it has been revealed that by using calculators teachers can ask different mathematics problems that are closely related to real life scenarios. Similarly, in the current research study majority of the in-service and pre-service high school mathematics teachers (75%) agreed that with the appropriate use of calculators, more challenging and interesting mathematics problems could be solved during mathematics instruction.

The results showed in-service high school mathematics teachers have a tendency to use traditional methods more than pre-service high school mathematics teachers in mathematics instruction. However, both pre-service and in-service high school mathematics teachers indicated that they want their students to learn how to use calculators. Moreover, they believe that using calculators would be helpful for the students by enabling them to solve different types of mathematics problems that students are not familiar with or have not encountered in mathematics lessons before.

In the analysis of the research question 4, the results showed that there was no statistically significant ($z=-0.34$, $p>.05$) difference between the responses of male and female high school mathematics teachers. Male high school mathematics teachers' mean rank score was 31.78, while female high school mathematics teachers' mean rank score was 30.03. The findings showed that male and female, the in-service and pre-service high school mathematics teachers responded similarly to the same survey items of the research study. Conversely, in their research study Almekhlafi and Almeqdadi (2010), indicated that there were significant differences between the perceptions of male and female teachers about the use of technology in their classrooms. Their research study revealed that because female teachers used calculators more frequently than male teachers during their schooling, female teachers have more positive attitudes about using technology.

Similarly, no statistically significant difference ($z=-0.93$, $p>.05$) found between the responses of the in-service private and those of public school mathematics teachers. This indicated that the participants, no matter whether they are private or public high school teachers, the in-service high school mathematics teachers have similar views,

attitudes and beliefs about using digital technology, specifically calculators in mathematics teaching and learning process. Conversely, in his research study Ersoy (2003) reached the conclusion that even public high school mathematics teachers indicated that they have enough experience with calculators private high school mathematics teachers have more positive views about using calculators. Results of the research study revealed that while 61% of private high school mathematics teachers agreed that they want to use calculators in their classrooms, only 20% of the public high school mathematics teachers agreed with the same item.

**Different points between the responses of pre-service and in-service teachers**

Another finding of the study was that there was a statistically significant ($z=-2.62$, $p=.01$) difference between the responses of the pre-service and in-service high school mathematics teachers. Most of the statistically significant differences were found in category 3 regarding teachers' beliefs about the benefits of using calculators during mathematics instruction. For example, through frequency tables, it is revealed that while the pre-service high school mathematics teachers mostly agreed that "calculators are motivational" (67.8%) and "using calculators make students try harder" (45.2%), the in-service high school mathematics teachers mostly disagreed with the same items with the percentages (55.2%) and (82.7%) respectively. The in-service high school mathematics teachers' responses contradict with several research findings. According to several research studies, using calculators motivate students to learn mathematics and help them to cultivate positive attitudes towards learning mathematics (Ardahan & Ersoy, 2002; Idris 2006). Another statistically significant difference was found on the item about teachers' views on having calculators available in their classrooms to use during instruction. While the pre-service high

school mathematics teachers mostly agreed with this item (70.9%), the in-service high school mathematics teachers disagreed (50%). In their research studies Göğüş (2008) and Simmt (1997) reached the conclusion that mathematics teachers mostly think that having calculators available during mathematics instruction is helpful for them as they enable to achieve more than one goal during instruction. In Göğüş's (2008) and Simmt's (1997) research studies, teachers mainly stated that they spend less time on solving questions with the help of calculators and thus they have more time to do mathematical exploration and investigation. Moreover, there was a statistically significant difference between the pre-service and the in-service high school mathematics teachers' responses to the item about students' use of calculators while doing mathematics homework. While the pre-service high school mathematics teachers agreed (74.2%) that students should use calculators when they are doing their mathematics homework, the in-service high school mathematics teachers disagreed (51.7%). The in-service high school participants indicated that allowing students to use calculators at home will cause them to be dependent on calculators all the time (Özgün-Koca, 2009). As can be seen in the foregoing discussion, the present study showed that in-service and pre-service high school mathematics teachers had different views about the same issues. The divergence of views among teachers can be explained by their previous experience with the use of calculators in the classroom, their TPCK levels, their confidence about using this technology during instruction and their experience in teaching (Kocasaraç, 2003; Koehler & Mishra, 2009). In the present study, it has been observed that the participants from different schools and universities have different experiences with calculators. For example, during the informal talks with the researcher, several in-service high school mathematics teachers indicated that even though they want to use calculators during

mathematics instruction, they do not know how to integrate them into their classes effectively, mainly because they do not have enough experience. Similarly, the pre-service high school mathematics teachers indicated that before they joined the teacher education program, they did not have any experience with the use of this technology. Therefore, they hardly felt confident about using this technology in the classroom.

The findings of the study showed that there was statistically significant difference in their responses of the pre-service high school mathematics teachers who received their teacher education from private university and those from public university in category basis. From here it can be interpreted that pre-service high school mathematics teachers who received their teacher education from private universities have different views and beliefs about the cognitive effects and benefits of using calculators during instruction than those from public universities. Those different views can be explained with pre-service teachers' different TPCK levels. Because pre-service teachers from different universities have different TPCK levels, they may not know the effective ways to use technology during instruction. Therefore, pre-service teachers from different universities may have different views about using technology, calculators in particular in their classrooms. For instance, while the majority of the pre-service high school teachers who received their teacher education from private university disagreed (89.5%) that calculators should be used after students have solved the mathematics questions in traditional ways, the pre-service high school mathematics teachers who received their teacher education from public university agreed (55.2%). The pre-service high school mathematics teachers' response can be explained with the findings of the following research study. In their

research study, Ardahan and Ersoy (2002) stated that since most of the mathematics teachers think that students may want to do all the calculations with calculators, they may lose their arithmetic skills by doing so. Hence, they argue that it is better to teach students how to solve mathematics problems in a traditional way by using paper and pencil.

Similarly, statistically significant differences ($z=-2.80$, $p<0.5$) were found in the items about benefits of using calculators during mathematics instruction. On the related items: "calculators are motivational, calculators make mathematics fun, more interesting mathematics problems can be done by using calculators", the pre-service high school mathematics teachers who received their teacher education from private university agreed (89.5%, 50.0%, 75.0%) while those of from public university disagreed (66.7%, 83.3%, 50.0%). Those different views can be explained with the fact that different professional education that universities offer for their pre-service teachers. Although all the pre-service teachers take the same courses that the Turkish Higher Education Council requires in order to be a qualified as a teacher in Turkey, in different universities different opportunities provided for pre-service teachers (Gündüz & Odabaşı, 2004). For example, in the sample of the study, the pre-service teachers who received their teacher education from a private university indicated during informal interviews with the researcher that they are doing internships at schools with better technological resources. Thus, they have a chance to use technology and have first-hand experience of its benefits during their teacher education. On the other hand, the pre-service high school mathematics teachers who received their teacher education from public university indicated that they have little chance to use any type of technology including calculators during their internship at

public schools. The pre-service high school mathematics teachers who received their teacher education from private university also indicated that their instructors attach great importance to integration of technology in lessons. Those pre-service teachers mainly stated that they are preparing their lesson plans, assignments and project works by integrating technology. Thus, in the sample of the study of the pre-service high school mathematics teachers who receive their teacher education program from a private university stated that they use and observe technology including calculators more often than their colleagues who received their education from a public university.

## Implications for practice and further research

This research study investigated Turkish pre-service and in-service high school mathematics teachers' beliefs and views about using technology, particularly calculators, in their classrooms. The results of the study show that there are certain similarities as well as differences in pre-service and in-service high school mathematics teachers' views, beliefs and attitudes about using technology, particularly calculators, during mathematics instruction.

In the research study it has been revealed that majority of the in-service high school mathematics teachers believe that students will learn mathematics better by using traditional teaching methods. On the other hand, the in-service high school mathematics teachers indicated that all students should learn how to use calculators. At this point, it seems that there is a contradiction between the ideas of the in-service high school teachers. Although they believe that all students should learn how to use calculators, they do not want to use calculators during mathematics instruction. Thus,

a further research study should be conducted in order to analyze this contradiction. Moreover, in a wider perspective this result could be evidence that it may not be very easy to implement FATİH Project in Turkish classrooms because of the in-service teachers' beliefs regarding the use of technology.

The results show that pre-service high school mathematics teachers have higher positive attitudes, beliefs and views about using calculators during instruction than in-service high school teachers. The pre-service high school mathematics teachers mainly stated that they intend to use calculators and they believe the positive effects of calculator usage on students' achievement during mathematics instruction. At this point, a follow-up research study can be conducted in order to find out pre-service high school mathematics teachers' beliefs attitudes and views about using calculators when they become experienced in-service high school mathematics teachers. A follow-up research study can be conducted in order to investigate whether there is a change in pre-service teachers' beliefs attitudes and views towards using calculators or not.

The in-service and pre-service high school mathematics teachers who participated in the present research study mostly claimed that they know how to use calculators effectively during mathematics instruction. At this point, a research study can be conducted in order to evaluate the proficiency of mathematics teachers in using calculators during mathematics instruction. In the wider perspective, by looking at the results, possible use of calculators in Turkish classrooms can be predicted.

The findings of the third research question revealed that there was a statistically significant difference between the beliefs, views and attitudes of pre-service and in-service high school mathematics teachers' responses about using digital technology particularly calculators in classrooms. A further research study can be conducted in order to find out the reasons of different views, beliefs and attitudes towards use of technology particularly calculators between pre-service and in-service high school mathematics teachers. Therefore, a further study can be conducted in order to improve the use of technology in mathematics classrooms.

## Limitations

This study explored pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology, particularly calculators, in their classrooms. A survey was used in order to collect the necessary data. The survey consisted of Likert-type items. However, using just Likert-type survey items limited the findings of the research study at some points. In a further research study, open-ended questions could also be added to the survey in order to learn more about high school mathematics teachers' philosophies, prior knowledge and experience in using technology in teaching and learning process.

In addition to the survey, interviews with high school pre-service and in-service mathematics teachers can also be conducted. With the help of survey results and the interviews, the researcher could have a better understanding of mathematics teachers' willingness to use technology during mathematics instructions and thus a better prediction can be made about the future use of technology in classrooms.

The researcher had to narrow the number of high schools and universities to be included in the research because of time limitations to complete this research study. In order to have more accurate and comprehensive results, the number of the participants can be raised by conducting the research study in different regions of Turkey. In addition to all these, the participants had to be chosen from local schools and universities which the researchers could easily visit and make necessary arrangements and conduct surveys.

Rather than these, using a survey model designed in 1995 is another limitation of the study. The researcher decided to use the survey because of the following reasons: (i) the survey directly addressed the research questions of the present study, (ii) the survey was not too long and complex to respond, (iii) there were not many subscales of the survey questions, (iv) the survey was analyzed in terms of reliability and validity, (v) calculators were not as complex or new as other dynamic software so it was assumed that high school mathematics teachers in Turkey have an idea about this type of technology. Finally, the researcher assumed that the participants who agreed to participate in the research study voluntarily responded the survey and interview questions sincerely and ethically.

## Conclusion

The present research study found out Turkish pre-service and in-service mathematics teachers' beliefs and views about using digital technology, particularly calculators, in their mathematics classrooms in order to provide some insights into the use of technology in mathematics classrooms. The research questions of the current research study were: (i) What beliefs and views do **in-service** high school

mathematics teachers have about using digital technology specifically calculators in classrooms? (ii) What beliefs and views do **pre-service** high school mathematics teachers have about using digital technology specifically calculators in classrooms? (iii) Is there a statistically significant difference between pre-service and in-service high school mathematics teachers' beliefs and views about using digital technology specifically calculators in mathematics classrooms? (iv) Is there a statistically significant difference between female and male high school mathematics teachers' (both pre-service and in-service) beliefs and views about using digital technology specifically calculators in mathematics classrooms? (v) Is there a statistically significant difference between in-service private and public high school mathematics beliefs and views about using digital technology specifically calculators in mathematics classrooms? (vi) Is there a statistically significant difference between pre-service high school mathematics teachers who received their teacher education program from private universities and those from public universities in terms of their beliefs and views about using digital technology specifically calculators in mathematics classrooms?

The sample consisted of 31 pre-service and 29 in-service high school mathematics teachers from 2 different universities and 5 different high schools in Turkey. A survey was used in order to collect the data (Appendix 1). In-service and pre-service high school mathematics teachers participated in this research study by responding to the same survey questions. The collected data were analyzed statistically by using SPSS 20.0. For the first and the second research questions, frequency tables were used in order to find the possible answers. A Mann Whitney *U* test was conducted for other research questions (questions 3, 4, 5 and 6).

The results of the study showed that there was a statistically significant difference between the responses of pre-service and in-service high school mathematics teachers' about using digital technology, particularly calculators in their classrooms. Moreover, the results revealed that there was a statistical difference between the responses of pre-service high school mathematics teachers who received their teacher education program from public universities and those from private universities. However, no statistically significant difference was found between in-service high school mathematics teachers who teach at private and public schools. No significant difference has been observed between the male and female participants.

The findings of the present study showed that pre-service high school mathematics teachers have higher positive beliefs and views towards using digital technology, particularly calculators in their classrooms than in-service high school mathematics teachers. In-service high school mathematics teachers mainly indicated that, using calculators can make the students lazy as they may want to do all calculations with it. On the other hand, pre-service high school mathematics teachers seem to believe the positive effects of using this technology during mathematics instruction. Those different views can be because of in-service and pre-service teachers' different TPCK levels. Because the use of technology has become more important in education recently, pre-service high school mathematics teachers could have more experience with calculators and other technological tools than in-service high school mathematics teachers. It may for that reason pre-service high school mathematics teachers have a tendency to use technology more than in-service high school mathematics teachers. At that point, I would suggest to the policy makers to prepare workshops for in-service teachers where they improve their TPCK by learning and

actively using technologic tools. I would also suggest that extra salary or rewards can be given for the teachers who actively use technology during instruction in classrooms. Additionally, curriculum of the teacher education programs can be changed by integrating more lectures about how to teach by using technology and thus pre-service teachers' TPCK levels could be improved. By this way, I believe knowing the importance of using technology during instruction and effective ways to use it future teachers will use technology in their classrooms more often.

Consequently, with the help of all these suggestions and light of findings of the research study it is hoped that the use of digital technology will improve in Turkish mathematics classrooms in the future so that extensive projects like FATİH Project can be implemented more effectively.

## REFERENCES


Akbaba-Altun, S. (2006). Complexity of integrating computer technologies into education in Turkey. *Journal of Educational Technology and Society, 9*(1), 176.

Akgün, E., Yılmaz, E. O., & Seferoğlu, S. S. (2011). Vizyon 2023 strateji belgesi ve fırsatları artırma ve teknolojiyi iyileştirme hareketi (FATİH) Projesi: Karşılaştırmalı bir inceleme. *Akademik Bilişim,* 2-4.

Akkoç, H. (2011). Investigating the development of prospective mathematics teachers' technological pedagogical content knowledge. *Research in Mathematics Education, 13*(1), 75-76.

Akşit, N. (2007). Educational reform in Turkey. *International Journal of Educational Development, 27*(2), 129-137.

Almekhlafi, A. G., & Almeqdadi, F. A. (2010). Teachers' perceptions of technology integration in the United Arab Emirates school classrooms. *Journal of Educational Technology and Society, 13*(1).

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*(1), 154-168.

Ardahan, H., & Ersoy Y. (2002). *TI-92 destekli matematik öğretimi-II: Matematik öğretmen adaylarının görüşleri.* Retrieved January 27, 2009, from http://www.fedu.metu.edu.tr/ufbmek5/b_kitabi/PDF/Matematik/MiniSempozyum/t198DA.pdf.

Arghode, V. (2012). Qualitative and quantitative research: Paradigmatic differences. *Global Education Journal, 2012*(4).

Argün, Z., Arıkan, A., Bulut, S., & Sriraman, B. (2010). A brief history of mathematics education in Turkey: K-12 mathematics curricula. *ZDM The International Journal on Mathematics Education, 42*(5), 429-441.

Attewel, P., & Battle, J. (1999). Home computers and school performance. *Information Society, 15*(1), 1-10.

Aydın, B. (2003). Bilgi toplumu oluşumunda bireylerin yerleştirilmesi ve matematik eğitimi. *Pamukkale Üniversitesi Eğitim Bilimleri Dergisi, 2*(14), 183-190.

Baki, A., & Çelik, D. (2005). Grafik hesap makinelerinin matematik derslerine adaptasyonu ile ilgili matematik öğretmenlerinin görüşleri. *Tuskish Online Journal of Educational Technology, 4*(4), 146-162.

Ball, D. L., Lubienski, S. T., & Mewborn, D. S. (2001). Research on teaching mathematics: The unsolved problems of teachers' mathematical knowledge. *Handbook of Research on Teaching, 4,* 433-456.

Bittler, G. G., & Hatfield M. M. (1992). *Integration of the math explorer calculator into the mathematics curriculum: The calculator project report.* Tempe, AZ: Arizona State University, Technological Based Learning and Research.

Burrill, G., Allison, J., Breaux, G., Kastberg, S., Leatham, K., & Sanchez, W. (2002). *Handheld graphing technology in secondary mathematics:* Texas Instruments.

Chamblee, G., Slough, S., & Wunsch, G. (2008). Measuring high school mathematics teachers' concerns about graphing calculators and change: A year long study. *Journal of Computers in Mathematics and Science Teaching*, *27*(2), 183-194.

Close, S., Oldham, E., Shiel, G., & O'Leary, M. (2012). Effects of calculators on mathematics achievement and attitudes of ninth-grade students. *The Journal of Educational Research, 105*(6), 377-390.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative and mixed methods approaches:* Sage.

Çakıroğlu, E., & Çakıroğlu, J. (2003). Reflections on teacher education in Turkey. *Europian Journal of Teacher Education, 26*(2), 253-264.

Çatma, Z. (2013). *Sınavla öğrenci alan ortaöğretim kurumlarında görevli matematik Öğretmenlerinin teknoloji alanındaki özgüven seviyeleri üzerine nicel bir Çalışma* [How special are teachers of specialized schools? A quantitative investigation of Turkish mathematics teachers' self-confidence levels in the technology domain]. (Unpublished Master's thesis). Bilkent University, Ankara, Turkey.

Çelen, F. K., Çelik, A., & Seferoğlu, S. S. (2011). Türk eğitim sistemi ve PISA sonuçları. XIII. *Akademik Bilişim Konferansı,* 2-4.

Demana, F. (2000). Calculators in mathematics teaching and learning. *Learning Mathematics for a New Century*, 51.

Doerr, H. M., & Zangor, R. (2000). Creating meaning for and with the graphing calculator. *Educational Studies in Mathematics, 41*(2), 143-163.

Durmuş, S., & Karakirik, E. (2006). Virtual manipulatives in mathematics education: A theoretical framework. *Turkish Online Journal of Educational Technology, 5*(1).

Erbaş, A. K. (2005). Çoklu gösterimlerle problem çözme ve teknolojinin rolü. *The Turkish Online Journal of Educational Technology, 4*(4), 88-92.

Erdemir, N., Bakırcı, H., & Eyduran, E. (2009). Öğretmen adaylarının eğitimde teknolojiyi kullanabilme özgüvenlerinin tespiti. *Türk Fen Eğitimi Dergisi, 6*(3), 99-108.

Ersoy, Y. (2002). Hesap makinesi destekli Matematik öğretimi: Öğretmen görüşleri ve genel eğilimler.*V. Ulusal Fen ve Matematik Eğitim Bilimleri Kongresi. Ankara.* Retrieved from http://www.fedu.odtu.edu.tr/ufbmek-5/netscape/b_kitabi/PDF/Matematik/MiniSempozyum/t201DA.pdf.

Ersoy, Y. (2003). Teknoloji destekli matematik eğitimi-1: Gelişmeler, politikalar ve stratejiler. *İlköğretim-Online, 2*(1), 18-27.

Fey, J. T. (1989). Technology and mathematics education: A survey of recent developments and important problems. *Educational Studies in Mathematics, 20*(3), 237-272.

Fleener, M. J. (1995). A survey of mathematics teachers' attitudes about calculators: The impact of philosophical orientation. *Journal of Computers in Mathematics and Science Teaching*, *14*(4), 481-498.

Göğüş, A. (2008). Teachers' perceptions about the usefulness of integrating a digital device into high school mathematics classrooms. *Proceeding of the IADIS International Conference on Cognition & Exploratory Learning in Digital Age*, 337-380.

Grandgenett, N. (2008). Perhaps a matter of imagination: TPCK in mathematics education. *Handbook of technological pedagogical content knowledge (TPCK) for educators*, 145-166.

Gündüz, Ş., & Odabaşı, F. (2004). Bilgi çağında öğretmen adaylarının eğitiminde öğretim teknolojileri ve materyel geliştirme dersinin önemi. *The Turkish Online Journal of Educational Technology, 3*(1), 7.

Gürol, M., Donmuş, V., & Arslan, M. (2012). İlköğretim kademesinde görev yapan sınıf öğretmenlerinin FATİH projesi ile ilgili görüşleri. *Eğitim Teknolojileri Araştırma Dergisi, 3*(3).

Gürşimşek, I., Kaptan, F., & Erkan, S. (1997). General view of teacher education policies in Turkey. *Paper presented at the 49th AACTE Annual Meeting,* Phoenix, Arizona.

Hennessy, S., Fung, P., & Scanlon, E. (2001). The role of graphing calculator in mediating graphical activity. *International Journal of Mathematical Education in Science and Technology, 32*(2), 267-290.

Hooper, S., & Rieber, L. P. (1995). Teaching with technology. *Teaching: Theory into practice,* 2013, 154-170.

Huang, S. (1993). Investigating middle school students' attitudes towards calculator use. *Technology and Teacher Education Annual,* 514-518.

Idris, N. (2006). Exploring the effects of Ti-84 plus on achievement and anxiety in mathematics. *Eurasia Journal of Mathematics, Science and Technology Education, 2*(3), 66-78.

Kağızmanlı, T. B., & Tatar, E. (2012). Matematik öğretmen adaylarının bilgisayar destekli öğretim hakkındaki görüşleri: Türevin uygulamaları örneği. *Kastamonu Eğitim Dergisi, 20*(3), 897-912.

Kayaduman, H., Sırakaya, M., & Seferoğlu, S. S. (2011). Eğitimde Fatih projesinin öğretmenlerin yeterlik durumları açısından incelenmesi. *Akademik Bilişim.*

Keong, C., Horani, S., Daniel, J. (2005). A study on the use of ICT in mathematics teaching. *Malaysian Online Journal of Instructional Technology, 2*(3), 43-51.

Kocasaraç, H. (2003). Bilgisayarın öğretim alanında kullanımına ilişkin öğretmen yeterlilikleri. *The Turkish Online Journal of Educational Technology, 2*(3), 77-86.

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Education Computing Research, 32*(2), 131-152.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPCK)? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Ministry of National Education [MoNE]. (2012a). *Fatih Project* [Webpage]. Retrieved from http://fatihprojesi.meb.gov.tr/tr/icerikincele.php?id=6.

Ministry of National Education [MoNE]. (2012b). *Fatih Project: Towards the education of information age.* Retrieved from http://fatihprojesi.meb.gov.tr/tr/icerikincele.php?id=12.

Ministry of National Education [MoNE]. (2013). *Ortaöğretim matematik dersi öğretim programı* [Secondary schools mathematics curriculum]. Ankara, Turkey: Author.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *The Teachers College Record, 108*(6), 1017-1054.

Nachar, N. (2008). The Mann Whitney U: A test for assessing whether two independent samples come from the same distribution. *Tutorials in Quantitative Methods for Psychology*, *4*(1), 13-20.

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2008). *The role of technology in the teaching and learning mathematics.* Reston, VA: Author.

Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education, 21*(5), 509-523.

Özgen, K., Narlı, S., & Alkan, H. (2013). Matematik öğretmen adaylarının teknolojik, pedagojik alan bilgileri ve teknoloji kullanım sıklığı algılarının incelenmesi. *Electronic Journal of Science, 12*(44).

Özgün-Koca, S. A. (2009). The views of pre-service mathematics teachers about the strengths and limitations of the use of graphing calculators in mathematics instruction.

Pierce, R., Stacey, K., & Barkatsas, A. (2007). A scale for monitoring students' attitudes to learning mathematics with technology. *Computers & Education, 48*(2), 285-300.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPCK): The development and validation of an assessment instrument for pre-service teachers. *Journal of Research on Computing in Education, 42*(2), 123.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Simmt, E. (1997). Graphing calculators in high school mathematics. *Journal of Computers in Mathematics and Science Teaching, 16*(2-3), 269-289.

Simonsen, L. M., & Dick, T. P. (1997). Teachers' perceptions of the impact of graphing calculators in the mathematics classroom. *Journal of Computers in Mathematics and Science Teaching, 16*(2-3), 239-268.

Tarman, B. (2010). Global perspectives and challenges on teacher education in Turkey. *International Journal of Arts & Science (IJAS), 3*(17), 78-96.

Taylor, S., & Bogdan, R. (1984). *Introduction to research methods*: New York: Wiley.

Waits, B. K., & Demana, F. (2000). Calculators in mathematics teaching and learning: Past, present, and future. *Learning Mathematics for a New Century*, 51-66.

Webster's Dictionary. (1992). New York, MA: Random House Webster, Inc.

Yüksel, İ., & Alemdar, M. (2012). Teachers' ICT integration stages on the eve of FATİH project. *Problems of education in the 21st century, 44.*

Zhao, Y. (2003). *What should teachers should know about technology?: perspectives and practices:* Information Age Pub Incorporated.

# APPENDICES

## APPENDIX 1: Data collection instrument

Değerli katılımcılar,

Doldurmakta olacağınız anket lise matematik öğretmen ve öğretmen adaylarının sınıflarında dijital teknolojiyi, özellikle hesap makinelerini kullanıp kullanmama konusundaki inanç ve tutumlarını ortaya çıkarmak amacı ile düzenlenmiştir. Anket sorularına vereceğiniz cevaplar gizli kalacak ve kimseyle paylaşılmayacaktır. Anketi cevaplandırdığınız için şimdiden çok teşekkür ederim.

Saygılarımla,

Pelin Konuk

pelin.konuk@bilkent.edu.tr

Cinsiyetiniz: ( ) Kadın ( ) Erkek Yaşınız: Hizmet Süreniz:

Aşağıda verilen maddelere ne ölçüde katıldığınızı işaretleyiniz.

| **Maddeler** | Kesinlikle katılıyorum | Katılıyorum | Katılmıyorum | Kesinlikle katılmıyorum |
|---|---|---|---|---|
| 1. Öğrenciler matematik sınavı olurken hesap makinesi kullanımına izin verilmemelidir. | | | | |
| 2. Hesap makinesi kullanımı basit aritmetik bilgisinin gerilemesine sebep olur. | | | | |
| 3. Hesap makineleri motivasyon sağlar. | | | | |
| 4. Hesap makineleri matematiği eğlenceli hale getirir. | | | | |

| **Maddeler** | Kesinlikle katılıyorum | Katılıyorum | Katılmıyorum | Kesinlikle katılmıyorum |
|---|---|---|---|---|
| 5. Öğrenciler hesap makineleriyle çalıştığında yaptıkları işlemleri kağıtlarında göstermelerine gerek yoktur. | | | | |
| 6. Matematik problem çözme hesap makineleri kullanıldığında daha kolaydır. | | | | |
| 7. Öğrencilerin hesap makinelerine erişimi sağlandığında daha ilginç matematik problemleri yapılabilir. | | | | |
| 8. Öğrenciler problemleri kağıt kalem kullanarak çözerse matematiği daha iyi anlar. | | | | |
| 9. Öğrenciler kavram ya da işlemlere hakim olmadıkları sürece hesap makineleri kullanmalarına izin verilmemelidir. | | | | |
| 10. Her öğrenci hesap makinesi kullanmayı öğrenmelidir. | | | | |
| 11. Hesap makinesi kullanmak öğrencilerin daha sıkı çalışmalarına yol açar. | | | | |
| 12. Hesap makineleri yalnızca problem kağıt üzerinde çözüldükten sonra işlemi kontrol etme amacıyla kullanılmalıdır. | | | | |
| 13. Hesap makineleri matematik ödevlerinde kullanılmalıdır. | | | | |
| 14. Hesap makinelerini kullanmak öğrencilerin temel işlem yeteneklerini kaybetmelerine neden olur. | | | | |
| 15. Hesap makinelerini kullanmak öğrencilerin daha iyi problem çözücü olmalarını sağlar. | | | | |
| 16. Devamlı hesap makinesi kullanımı öğrencilerin tahmin yeteneklerinin azalmasına yol açar. | | | | |
| 17. Sınıfımda/sınıflarımda kullanmak üzere hazır hesap makinelerinin olması işimi | | | | |

| | | | | |
|---|---|---|---|---|
| kolaylaştırır. | | | | |
| **Maddeler** | Kesinlikle katılıyorum | Katılıyorum | Katılmıyorum | Kesinlikle katılmıyorum |
| 18. Öğrencilerimin çoğunun kendi hesap makineleri olmasını isterim. | | | | |
| 19. Hesap makineleri yalnızca hesaplamaların daha hızlı yapılması için bir araçtır. | | | | |
| 20. Eğitimim süresince grafik hesap makineleri kullandım. | | | | |
| 21. Bilimsel hesap makinelerini kullanmak konusunda ustayım. | | | | |
| 22. Sınıflarımda hesap makinelerini etkin kullanma yollarını biliyorum. | | | | |
| 23. Hesap makinesinden nasıl yararlanılabileceğim konusunda birçok fikrim var. | | | | |