INVESTIGATION OF MIDDLE GRADE STUDENTS' ATTITUDES TOWARDS USE OF TECHNOLOGY IN MATHEMATICS LESSONS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF ELEMENTARY SCIENCE AND MATHEMATICS EDUCATION

JULY 2015

Approval of the Graduate School of Social Sciences

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

INVESTIGATION OF ATTITUDES OF MIDDLE GRADE STUDENTS TOWARDS USE OF TECHNOLOGY IN MATHEMATICS LESSONS

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July 2015, 150 pages

The initial aim of the study is to develop a valid and reliable scale in order to measure attitudes of middle school students towards the use of technology in mathematics lessons and then, to examine elementary students' attitudes towards the use of technology in mathematics lesson. Moreover, the current study is sought to explore whether these attitudes of elementary students towards the use of technology in mathematics lesson differs by gender and grade level, respectively.

Data was collected in the spring term of 2014-2015 academic year from 571 middle grade students. Those students are from five private and one public school in Çankaya in Ankara and all participating schools use various technological tools in mathematics lessons. As data collection instrument, Technology Usage in Mathematics Lessons Attitude (TMLA) Scale was administrated.

Exploratory and confirmatory factor analysis results revealed that TMLA Scale is valid and reliable instrument to measure attitudes towards use of technology in mathematics lessons. Based on results of descriptive analysis, middle grade students have moderately high attitudes towards use of technology. Moreover, independent sample t-test results indicated that female students possess significantly higher higher attitudes towards technology use in mathematics lessons when compared with male. Lastly, according to one-way ANOVA results, middle grade school students' attitudes towards technology usage in math lessons did not alter across grade level.

Keywords: Technology in Mathematics Education, Attitudes, Middle School Students

ÖZ

ORTAOKUL ÖĞRENCİLERİNİN MATEMATİK DERSLERİNDE TEKNOLOJİ KULLANIMINA YÖNELİK TUTUMLARININ İNCELENMESİ

Aytekin, Emine

Yüksek Lisans, İlköğretim Fen ve Matematik Alanları Eğitimi Bölümü

Tez Yöneticisi: Doç. Dr. Mine IŞIKSAL-BOSTAN

Temmuz 2015, 150 sayfa

Bu çalışmanın amacı, teknolojinin matematik derslerinde kullanılmasına yönelik geçerli ve güvenilir bir tutum ölçeği geliştirmek ve bu ölçeği kullanarak orta okul öğrencilerinin matematik derslerinde teknoloji kullanımına yönelik tutumlarını belirlemektir. Ayrıca ortaokul öğrencilerinin matematik derslerinde teknoloji kullanımına yönelik tutumlarında cinsiyet ve sınıf düzeyi farklılıkları da incelenmiştir.

Veriler, 2014-2015 eğitim öğretim yılının bahar döneminde 571 ortaokul öğrencisinden elde edilmiştir. Bu öğrenciler, Ankara ilinin Çankaya ilçesinde bulunan beş özel okul ve bir devlet okulundan olup, katılımcıların okullarında matematik derslerinde teknoloji kullanılmaktadır. Veri toplama aracı olarak Matematik Derslerinde Teknoloji Kullanımına İlişkin Tutum Ölçeği kullanılmıştır.

Açımlayıcı ve doğrulayıcı faktör analiz sonuçları geliştirilen ölçeğin geçerli ve güvenilir olduğunu göstermiştir. Betimsel istatistik sonuçlarına göre, ortaokul öğrencilerinin matematik derslerinde teknoloji kullanımına yönelik kısmen yüksek tutuma sahip oldukları görülmüştür. Ek olarak, bağımsız örneklemler t-testi sonucuna göre, kız öğrencilerin matematik derslerinde teknoloji kullanımına yönelik istatiksel olarak anlamlı düzeyde daha yüksek tutuma sahip oldukları bulunmuştur. Son olarak, Tek Yönlü Varyans Analizi sonucu sınıf düzeylerine göre ortaokul öğrencilerin tutumlarında istatiksel olarak anlamlı düzeyde farklılık olmadığını göstermiştir.

Anahtar Kelimeler: Matematik Eğitiminde Teknoloji, Tutum, Ortaokul Öğrencileri

To My Parents

Süreyya & Ahmet AYTEKİN

ACKNOWLEDGMENTS

I would express my deepest gratitude to my supervisor Assoc. Prof. Dr. Mine IŞIKSAL-BOSTAN who kept contact with me throughout the whole thesis writing process with her endless guidance, encouragement, insight and deep knowledge. She always believes in me and she tried to make me believe to finish the research. I learned a lot from her in this hard process.

I also would like to thank to my respectful instructors Prof. Dr. Erdinç ÇAKIROĞLU, Prof. Dr. Giray BERBEROĞLU, Assoc. Prof. Dr. Elvan ŞAHİN, Assoc. Prof. Dr. Çiğdem HASER, Assoc. Prof. Dr. Yusuf KOÇ, Assoc. Prof. Dr. Duygu ANIL, Assist. Prof. Dr. Didem AKYÜZ, Assist. Prof. Dr. Yeşim ÇAPA-AYDIN who shared their valuable suggestions and assistance with me. Their comments made this thesis more qualified.

In addition to my respectful instructors, I am also thankful to my office mates Birgül ÇAKIR, Nilay ÖZTÜRK, Okan ARSLAN, Dilber DEMİRTAŞ, Celal İLER, Sema SÖNMEZ, Elif BULDU, Tuna COŞKUN, Çağla ŞENDİL. Their friendship made easier to conduct this study.

I would also thank to Mehmet ŞEN for his endless encouragement, patience and devotion. Whenever I need help, he tried to do best for finishing the thesis. Also I would thank to Ayşenur KUBAR for her warm frienship and sensibility. She believed in me and motivated me for life and works.

Moreover, I would thank to my friends Sinem DEMİRCİ, Rukiye AYAN, Özlem ERKEK, Aysun ATA, Seçil YEMEN-KARPUZCU, Gözde KAPLAN, Aykut BULUT, Merve ARSLAN, Betül YENİTERZİ, İbrahim BİLİM, Filiz BEZCİ, Erdinç İŞBİLİR, Ayça ALAN, Belkıs GARİP. Whenever I need help they are always with me.

I would also thank to my friend and instructor Mustafa ALPASLAN for his endless support, kindness and help as well as his wife Zisan GÜNER-ALPASLAN for her kindness and encouragement. I will miss them dearly. Rest in peace with your children. I did not imagine to thank both of you like this unfortunately.

Friendship of Haydar KARAMAN is gratefully acknowledged. He has been with me in METU years and he believed in and supported me to become academician. I thank for his patience, sensibility and real friendship. I would also thank to Ahmet GÜL for his friendship and sense of humour.

I would also like to thank my roommates Şükran OKUR, Mercan YAVUZATMACA, Semanur KANDİL, Günseli DURMAZ, Seden DEMİRTAŞ and Selin GÜVEN for their kindness, frienships and sensibility.

I am also grateful to TÜBİTAK for their scholarship which is an important financial support for the current thesis.

Lastly, I dedicate this study to my lovely mother and father; Süreyya AYTEKİN and Ahmet AYTEKİN. I always feel their support and love which gives me perseverance to conduct this study. I am also thankful to my sister Rukiye AYTEKİN. She was always with me when I needed encouragement and motivation. Furthermore, I would also like to thank to my grandmothers who always prayed for my success.

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LIST OF ABBREVIATIONS

CFI: Comparative Fit Index

Df: Degrees of Freedom

GFI: Goodness of Fit Index

KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy

M: Mean

MoNE: Ministry of National Education

N: Sample Size

NC: Normed Chi-Square

NFI: Normed Fit Index

TMLAS: Technology in Mathematics Lessons Attitude Scale

p: Significance Level

RMSEA: Root Mean Square Error of Approximation

SD: Standard Deviation

CHAPTER I

INTRODUCTION

Technology holds an important place in many areas such as industry, agriculture, art, and media because people cannot disregard or ignore what technology brings to pupils' lives. It is a fact that technology makes people's life easier and continues to improve various aspects of daily life. Advancement in technology encourages and makes it inevitable for the society to make changes in their educational system and philosophy to reach standards of high quality education. In addition, Salinas (2008) pointed that technology has a crucial role in equipping citizens with the essential knowledge and skills for the 21st century.

Technology has become an inseparable part of education and provides teachers and students with many opportunities. Over the last fifty years, Information and Communication Technology (ICT) has made great progress in the field of education (Asıl, Teo& Noyes, 2014). For many years, the Organization for Economic Co-operation and Development (OECD) has identified that ICT is one of the five movements to reshape the future of education (OECD, 2013). In awareness of the positive impact of technology in education, Abbitt and Klett (2007) stated that the integration of technology into teaching in the K-12 classrooms has become one of the main foci of educational organizations. Accordingly, in order to ensure the quality of education, large amounts of money have been spent by educational organizations on providing schools with new technological devices (Brown & Warschauer, 2006). It is reported that between the years 1995 and 2001, the amount of money spent on educational technology in schools increased from $21 to $729 million in the U.S (Russell, Bebell, O'Dwyer & O'Connor, 2003). Moreover, the use of technology is promoted by many projects such as New Millenium Learners, ICT in Education, A

Survey of Schools: ICT in Education sponsored and carried out by the organizations, OECD, United Nations Organization for Education (Asıl, Teo& Noyes, 2014).

Some researchers believe that technology has power and potential to improve and reinforce the education system (Jonassen & Reeves, 1996). Accordingly, it is also highlighted by Zhang (2010) that “researchers from around the world have been exploring new learning programs, often supported by new technologies, to increase student capabilities of productive and collaborative knowledge work” (p.229). The number of studies on the use of technology in education is increasing and they report conclusions that using technology has major benefits in learning, teaching, achievement and motivation (Asıl, Teo& Noyes, 2014). Moreover, how technology affects education, whether students really learn better with the use of technology, how technology enhances cognitive processes of students are some of the main questions for which researchers seek the answers while defining the nature of technology in education.

Sociocultural theories of learning regards mathematics instruction as being comprised of social and communicative activities which lead to a learning environment shaped by the student-centered approach, communicative conventions and epistemological values (Galbraith, 2006). In such an environment, students do not totally depend on answers and knowledge of teachers, but on collaborative study and student discussion enhanced by teachers to make conjectures and present reasoning underlying ideas. Technological advances offer such a learning environment in all school courses. Mathematics is one of those courses which technology has an impact on the way of teaching and learning (Goldenberg, 2000). Advances in technology enable students to communicate and investigate mathematical properties and defend their arguments and way of thinking (Galbraith, 2006).

In addition, technology is regarded as one of the tools yielding amplification and reorganization of the mathematical knowledge through cognitive processes (Resnick et al., 1997). Goos and his colleagues (2003) developed a descriptive taxonomy of sophistication analyzing the use of graphic calculators by secondary students. Based on data obtained from observation and interviews held with students, levels of taxonomy for technology are defined as master, servant, partner and extension of self. When students consider technology as a partner or extension of the self, they are able to create new mathematical knowledge and indicate high performance in mathematics (Galbraith, 2006).

Particularly, Aydın (2005) stated that computer assisted instruction has many positive effects on mathematics education. One of those effects, as claimed by Aşkar, Yavuz and Köksal (1991) is that technology provides individualism in learning mathematics. Moreover, Nwabueze (2004) maintained that technologies have power to shift mathematics education from procedural understanding and thinking to conceptual understanding, problem solving, and reasoning. With reference to these benefits of technology, Schaffer and Kaput (1999) stated that technology is a 'thinking tool' which presents mathematics as a 'play' and enables students to build concepts. Besides, technology converts abstract mathematical concepts to concrete and visualized format and its dynamic and interactive features reinforces the relationship between students and mathematics. In brief, there are numerous studies revealing positive effects of technology on students' mathematical achievement (Hollebrands, 2003; Işıksal& Aşkar, 2005; Lester, 1996) and their development of a positive attitude towards mathematics and geometry (Boyraz, 2008; Ellighton 2004). In addition, active engagement, participation, feedback and relation with real life situations are promoted by technology (Roschelle et al., 2001).

In spite of the fact that technology creates a difference in students' achievement in mathematics lesson, students' motivation in learning mathematics, cognitive skills, and teaching methodologies in a positive way, simply making technology available and implementing it in education does not automatically guarantee students' learning (Adams, 2011). Effective integration of technology in the school curriculum and in classrooms relies on other factors, such as policies, pedagogical approaches, acceptance and engagement of technology by teachers and students (Asıl, Teo & Noyes, 2014).

If technology is a part of learning mathematics, there is a need to explore students' computer-related behaviours and attitudes (Asıl, Teo & Noyes, 2014) and their relationships with mathematics. In line with this statement, Kılıçoğlu and Altun (2002) emphasized that in addition to students' cognitive skills, students' affective and emotional readiness to use technology is worth investigating to evaluate the effective usage of technology in mathematics instruction. In addition, McLeod (1992) laid emphasis upon the fact that affective issues have an important role in learning mathematics.

The concept 'attitude' was first used in the field of art (Allport, 1935). Although the concept 'attitude' has a long history in educational studies, it is an ambiguous construct and is frequently used without being appropriately defined (Hannula, 2004). In the related literature, numerous definitions of attitudes can be encountered (Joyce & Kirakowski, 2013). According to Allport's early definition, attitude refers to "a mental or neural state of readiness, organized through experience, exerting a directive influence on the individual's response to all objects and situations to or dynamic which it is related" (Allport, 1935, p.810). In his definition, Allport emphasizes experience with objects or situations and the psychological condition of the individual. Recently, Aiken (2000) proposed a contemporary explanation, indicating that "attitude is a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (p.248). Positive or negative disposition to a particular object or situation is stressed in this definition. In more recent times, Eagly and Chaiken (2007) have proposed an attitude of definition as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavor" (p.1). The definition stresses the positive or negative disposition and psychological condition, much similar to Aiken's definition. The current study favors Aiken's attitude of definition.

Based on the definitions of attitudes, the three-component model has had a powerful place in attitude research for much of the fifty years (Joyce& Kirakowski, 2013). The tripartitetite (three-component) model of attitude and the theory of planned behaviour (Ajzen, 1988) present a base for Kay's model (1993), which is a theoretical framework used for measuring attitudes. In Kay's model four distinct dimensions of computer attitudes are proposed: affect (feelings), cognition (perception and information toward computer), conation or behavioral (intentions and actions to computers) and perceived-behavioral control (perceived ease or difficulty in using the computer). In the light of Fishbein and Ajzen's (1975) attitude paradigm, Davis (1993) designed the technology acceptance model. In addition to Kay's components, Davis (1993)'s technology acceptance model also included usefulness (the degree on which the computer is perceived to be useful in one's work), which has an impact on using computers. Based on this theory, some scales of attitude towards computers have been developed (e.g. Teo & Noyes, 2008).

Apart from theory, in accessible literature there are numerous studies regarding teachers' and prospective teachers' attitudes towards using technology or computer assisted instruction (e.g. Shattuck et al., 2011). However, there are few studies to be found in the literature on elementary students' attitudes towards the use of technology specifically in mathematics lessons. Therefore, there is very limited number of instruments measuring elementary students' attitudes (e.g. Galbraith et al., 1998; Pierce at al., 2007). The very few instruments that are present in literature are insufficient in term of the number of items they include in general and the number of specific items related with usefulness of technology in mathematics lessons. Moreover, in those scales only usefulness of technology is taken into consideration regardless of the emotional and conational aspect of attitude. For these reasons, the first aim of this study is to develop a valid and reliable scale to measure elementary students' attitudes towards using technology in mathematics lessons. Furthermore, it is aimed to determine elementary students' attitudes towards the use of technology in mathematics lessons. Beside this purpose, investigating gender differences is also important since gender is seen an important factor in research studies on learning mathematics and attitudes towards mathematics (Christensen, Knezek, & Overall, 2005; Kay, 1992; Shashaani, 1993; Whitley, 1997). Moreover, grade level is another factor in attitude studies (Baser et al., 2012; King, Bond, & Blandford, 2002). Revealing students' level of attitudes, gender and grade level differences in their attitudes are expected to be beneficial in interpreting efficacy of technology integration in mathematics lessons and in providing mathematics teachers feedback about their teaching using technology.

1.1. Purpose of the Study

The initial aim of the study is to develop a valid and reliable scale in order to measure attitudes of middle school students towards the use of technology in mathematics lessons. Another purpose of the study is to examine elementary students' attitudes towards the use of technology in mathematics lesson. Finally, the current study is sought to explore whether these attitudes of elementary students towards the use of technology in mathematics lesson differs by gender and grade level, respectively.

1.2. Research Questions and Hypotheses

The following are the main research questions and hypotheses investigated in accordance with the purposes of the study.

1) Is the scale of attitude toward the use of technology in mathematics lessons valid and reliable?

2) What are elementary students' attitudes towards using technology in mathematics lessons?

3) Is there a statistically significant mean difference in attitudes of Turkish elementary students towards use of technology in mathematics lesson in terms of gender?

H_0: There is no statistically significant mean difference between attitudes scores of Turkish female and male elementary students towards use of technology in mathematics lessons.

4) Is there a statistically significant mean difference in attitudes of Turkish elementary students towards use of technology in mathematics lessons in terms of grade level?

H_0: There is no statistically significant mean difference between attitudes of 5^{th}, 6^{th}, 7^{th} and 8^{th}grade elementary students towards use of technology in mathematics lessons.

1.3. Definition of Important Terms

The operational and constitutive definitions of important terms are presented below.

Technologies "tools, concepts, innovations, and advancements utilized in diverse educational settings (including distance, face-to-face, and hybrid forms of education)…" (George, 2010, p. 12).

Attitude is "a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (Aiken, 2000, p.248).

Technology integration is "a process of using existing tools, equipment and materials, including the use of electronic media, for the purpose of enhancing learning. It involves "managing and coordinating available instructional aids and resources in order to facilitate learning" (Okojie, Olinzock, and Okojie-Boulder, 2006, p.67).

Attitude Toward the use of Technology in Mathematics Lesson is “the degree to which students perceives that the use of computers in mathematics provides relevance for mathematics aids their learning of mathematics and contributes to their achievement in mathematics” (Vale& Leder, 2004, p.5). In this study, it is described as the degree to which students have enjoyment, anxiety and self-confidence toward technology in mathematics and to which students perceive that the use of computers in mathematics contribute their learning and achievement. It was measured via the TMLA Scale.

1.4. Significance of the Study

Many investments have been made to increase classrooms’ technological conditions and make students technology literate in Turkey. In 2010, the Ministry of National Education (MoNE) decided to start the FATIH project (Movement of Increasing Opportunities and Improving Technology). The project is planned to be completed in four years and nearly 750 million dollars will have been spent (MoNE, 2010). Primary and secondary schools received smart boards, projection devices and computers in line with the aim of the project. Moreover, 8500 tablet PCs in which simulations and textbooks are embedded were donated to schools in the pilot study. MoNE (2013) declared that all primary and secondary schools would be given tablet PCs. However, efficiency of this project mostly depends on students’ views and attitudes towards technology since successfully implementing computers and other technological tools in classrooms is associated with users’ acceptance and attitudes towards it (Teo, 2006). From different points of view, several researchers agreed on the fact that attitude is crucial and a critical factor in its use in education (Myers & Halpin, 2002; Reed et al., 2012). Hence, the findings regarding the investigation of students’ attitudes towards using technology in mathematics lessons could give an insight about students’ acceptance of technology in lessons in line with the project.

Several researchers, in their experimental studies, revealed that technology is beneficial in students’ mathematics achievement, conceptual understanding, motivation and enjoyment (Graff& Lebens, 2007; Hollebrands, 2003; Olkun et al., 2005). However, there is a need to tune in to what students can display in terms of their experiences, progress and opinion regarding technology in order to determine the efficiency of technology use in education with respect to students' points of view (Rudduck & Flutter, 2000). In other words, students at early ages are capable of evaluating the teaching approaches and analyzing their learning experience (McCallum et al., 2000; Rudduck & Flutter, 2000) and students are significant parts of the educational system. Hence, they should be seen as active participants of teaching and learning in the educational context. However, existing research studies mostly focus on teachers' generic attitudes towards technologies such as computers, Tablet PCs, and the Internet rather than elementary students' attitudes. Hence, only a few instruments attempt to measure students' attitude towards the use of technology especially in mathematics lessons. Therefore, investigating elementary students' attitudes towards the use of technology is expected to yield an overall view of their future decisions on using technology. Due to the lack of sufficient studies concerning elementary students' attitudes, there is also a lack of scales measuring elementary students' attitudes towards the use of technology specifically in mathematics lessons. Therefore, another significance of the current study is the development of the attitude instrument to measure students' attitudes towards use of technology in mathematics lessons. Thus, it is believed that this study will contribute to the literature on technology integration in schools by filling in the gap that is present regarding studies related to elementary students' attitude towards use of technology in mathematics lesson. Moreover, in the light of the findings of this study, it can be determined whether technology integration in mathematics education is effective or not and how Turkish students react to technology in their mathematics learning process. Hence, outcomes of the study might provide crucial information to teachers, teacher educator and program makers in terms of mathematics programs and students' level of readiness to use technology (Woodrow, 1992).

Both psychologists and computer educators have been interested in the gender of technology users and they claimed that computers, computer games and software are perceived as a male domain (Whitley, 1997). Furthermore, gender is seen as an important factor among affective issues in mathematics education (Yazıcı & Ertekin, 2010). In contrast, according to earlier findings girls believe that they enjoy themselves more in mathematics than boys (Vale& Leder, 2004). However, with the integration of technology and mathematics , it was reported by relevant studies that male students have higher attitudes towards technology use in mathematics education than female students (Barkatsas et al., 2009; Pierce et al., 2007; Vale& Leder, 2004). Hence, gender differences in students' motivational beliefs reagrding computers has been taken into consideration since it gives insight into how to decrease gender gap and understand male and female's decisions of their future careers related with technology. In addition to gender, grade level or age of students are other variables by which differences in attitudes of students can be predicted (Baser et al., 2012; King, Bond & Blandford, 2002). In accessible literature, there are limited studies whose results indicate that younger students have more positive attitudes than older students (e.g. Balta& Duran, 2015; Forgasz, 2004; Vale & Leder, 2004). In contrast to these studies, according to the results of a study by Ursini Sanchez (2008), it was found that students' attitudes towards technology use in mathematics increased from grade 7 to grade 9. Since there is a lack of studies regarding grade level differences in students' attitudes towards technology use in mathematics, exploration of grade level differences is students' attitudes scores could present crucial findings for teachers and curriculum planners.

1.5. My Motivation to Conduct the Study

In high school, my interaction with technology was little. However, at the beginning of university, I took some courses related with properties and facilities of computers such as how to use Microsoft Excel and Word. After learning the basic skills in using computers, I took a course named Instructional Technology and Material Development. In this course I have learned that visualizing shapes, figures or knowledge is crucial for younger students because different representations are powerful in facilitating the construction of conceptual understanding. In addition, I realized that quality of education can be ensured through the effective use of technology. Thus, as a teacher, I am aware of the power of the technology and, thus, decided to learn more about technology integration in math classrooms. For instance, spatial ability activity, as a simulation on the Internet, has broadened my horizon regarding how technology can be used and in which subject matter.

During the junior years of my undergraduate program, I took an elective course called Geogebra. During this lesson, basically I learned the benefits of technology in mathematics education and how to integrate technology into the lessons. Hence, I decided to study technology network. Moreover, during my internship period I observed that when technology is used in 8^{th} grade mathematics classrooms, students perceive that technology is used for entertainment rather than learning mathematical concepts. Hence they do not focus on the idea of learning thorough technology. This indicates that merely making technology available and its use in the classroom do not guarantee effective learning. Then I decided to explore students' reactions towards technology use in mathematics because students are an important part of education. Also the investigation of their responses could give an extensive frame in which benefits of technology and their emotional readiness can be revealed. Therefore, I decided to investigate students' points of view on the use of technology in mathematics lessons.

CHAPTER II

REVIEW OF LITERATURE

The current study aimed to initially develop a valid and reliable instrument to measure elementary students’ attitudes towards the use of technology in mathematics lessons and then, to investigate elementary students’ attitudes towards the use of technology in mathematics lessons through the use of this instrument. Moreover, this study also aimed to examine gender differences in attitudes of elementary students towards the use of technology in mathematics lessons. The final purpose of the study was to investigate differences in attitudes of elementary students towards technology use in mathematics lessons with respect to grade level.

In consideration of these research scopes, this chapter presents a broad review of the literature on technology in education in general, and specifically on the use of technology in mathematics education, and attitudes towards the use of technology in mathematics lessons. It consists of two main parts, namely technology and affective factors. The first part, technology, was explored under following subheadings: technology in education, benefits of technology, importance of technology in mathematics education and technological tools in mathematics education. The second part, attitude, is specifically based on the importance of measuring attitudes toward technology, scales for measuring computer attitudes, and theoretical background. Furthermore, it includes a section on gender and grade level, studies regarding attitudes toward the use of technology in math education, including those in the national context. Finally, the chapter ends with a summary of literature in order to present a general frame of literature.

2.1. Technology in Education

Technology is defined as the combination of both the hardware and the software (Heinich, Molenda, Russell, & Smaldino, 2002, p. 47). This broad definition is quite different from its definition and use in education.Velasquez-Bryant, (2002) basically defined educational technology as the use of computers for instruction and learning. A complex definition of educational technology was offered by Seels and Richey (1994), who defined it in terms of theory and practice of design, development, utilization, management and evaluation of learning process and outcomes. Laborde and Starase (2010) prefer to use technology in association with the words of computer, software and communication technology, which is favored in this research.

Over the last quarter of a century, advances and novelties in field of technology have increased. Naturally, technology has a profound impact on various fields of human life, including the field of education (Chen, 2004). Hence in the modern era, advances in technology have brought new perspectives on instructional philosophy and the process of education. Thus, these advances have an impact on the individual, information and society. Salinas (2008) pointed that "using technology as a fully instructional tool instead of an aid to teach or toy to fun, will conceive students who learn exploring and creating new knowledge, and be ready to the problems which await them in 21st century" (p.659). In order to meet the needs of new information society, students and teachers need to be equipped with certain skills. These skills are determined as being in need of information, reaching, selecting, organizing and using information, using technology, problem solving, cooperating and communicating (ISTE 1998). These skills can only be developed by establishing suitable learning environments in accordance with the expectation of the society and individuals. To establish suitable learning environments technology should be used in education for reaching, using and creating information (Akkoyunlu, 2002).

Constructivism, one of the recent learning theories with principles serving suitable learning environments, includes discovery learning and “real world” classroom tasks where the teacher serves as a guide (Costa, 2008). Yoders (2014) claimed that constructivism has two key terms, which are scaffolding and cognitive apprenticeship. The former represents high level support to make students achieve difficult tasks and the latter represents transfer knowledge by using specific ways such as demonstration and feedback. For accomplishing these, the constructivist approach supports an educational environment where teachers facilitate learning for students. In such an environment, students are responsible for their own learning and they actively build new understanding from previous knowledge and experiences (Hermans et al, 2008) with the help of autonomous activities. These activities have high intrinsic motivation that results in high achievement, performance and learning. At that point, the use of technology will serve active learning for students, provide rich learning environments (Kay & Knaack, 2008) and enhance technology-enhanced, student-centred teaching environments (Hannafin & Land, 1997). For instance, based on the study by Hermans and his colleagues (2008), it was found that teacher beliefs (constructivism and traditionalism) about teaching are a crucial determinant in explaining the reason why teachers use computers in the classroom.

Similarly, Sam, Othman and Nordin (2005) stated that technology extends the traditional educational structures. Advances in computer technology, software, multimedia and network resources lead to the implementation of new teaching strategies. Considering the benefits of technology in education, Smalley, Graff and Saunders (2001) suggest that understanding technology, catching up with new innovations and analyzing how students react to technology and how they learn concepts with technology are issues that should be considered in order to integrate technology into education. Hence, teachers and educational reformers should incorporate technology into the curriculum and detect weaknesses and strengths of innovations. In a study by Hermans et al. (2008), three main applications of using technology in education emerged. These are ‘use of educational software for training skills’, ‘differentiation’ and ‘cooperative learning’.

Considering these applications of using technology in education and the future of society, technology is seen a powerful source in the field of education. As Abbitt and Klett (2007) maintained, “In recent years, the integration of technology into K-12 classroom teaching has been a major focus of federal, state, and local public and private educational organizations” (p. 28). Hence, each society aimed to incorporate technology in education to present qualified instruction to young generations (Ministry of National Education (MONE), 2004). Moreover, Albirini (2006) stated that the introduction of technology into the Syrian educational system aims to reach standard of education and pursue the innovations. Considering the importance of technology, ICT (Information and Communication Technologies) is seen to be essential for all students and especially for those with limited occupational prospects. Therefore, many general secondary schools are equipped with computers, hardware, Internet access and computer-based learning software (Lebens, Graff& Mayers, 2009) to make students technology literate. With this respect, countries have spent large amounts of money to equip schools and educational settings with up-to-date technological tools in order to enhance the quality of education (Brown & Warschauer, 2006). It is reported that educational technology expenses increased from $21 to $729 million between the years 1995 and 2001 in the U.S (Russell, Bebell, O’Dwyer & O’Connor, 2003). Moreover, based on the recent National Education Technology Plan in the U.S., Zhao (2007) reports that over the past 10 years, almost every American K-12 school has been able to have access to the Internet and one computer has been available for a group of five students in general.

Computers are one of the important technological devices frequently used in education from the past to the present (Teo & Lee, 2008), and it has been recognized that computers have a powerful influence on learning in a positive way (Baki, 2000; Bingimlas, 2009). Some terms have emerged with the use of computer in instruction. Firstly, ‘computer-based instruction’ is defined as a method of instruction in which computers are used according to students’ pace in order to enhance motivation of students and build conceptual understanding (Yanpar, Şahin& Yıldırım, 1999). In these learning environments, students are responsible for their own learning process.

Hence, the role of the teacher has changed; the teacher is no longer regarded as the authority for providing information. Secondly, computer-assisted instruction is referred to as a technique in which computers are used for providing feedback, and making students more interested in classroom activities (Hollebrands, 2007).

One of the other computer applications is software and Alessi and Trollip (2001) classified instruction via software into five categories: tutorial, drill and practice, simulation, educational games and hypermedia. Such software should be integrated into certain activities for the presentation of information, demonstration, practice and assessment. Hence, learning could become more efficient through appropriate software programs (Horzum& Balta, 2008). More recently, Tablet PC's (El-Gayar et al, 2011), Interactive White Boards (Lee, 2010) and interactive tabletops (Jackson et al., 2013) have been used to facilitate learning. Considering the power of technological tools in education, technology provides many advantages in teaching, learning and the curriculum.

In addition to computers, several studies indicated that computers and information and communication technologies (ICT), basically including computers and other technologies, have an influential power on the improvement of students' achievement and knowledge of teacher (Bransford et al., 2000). For instance, based on the results of PISA 2009 for Turkey, Delen and Bulut (2011) found a positive relationship between ICT use and students' achievement. Moreover, it is a key to prepare students to meet the 21st century needs and to effectively take part in the modern-day society's workplace (Hopson, Simms & Knezek, 2002). Thus, ICT is claimed to be a medium for socialization and enculturation in technology literacy (Lim, 2002). In this respect, huge investments have been made to integrate technology into the education system of most countries. For example, in 2006 in Turkey, 11.7% of the budget was allocated to ICT, which is an equivalent of $400 per capita (Göktaş, 2012). By the end of 2007, 604,000 computers had been delivered to schools. 87% of 45,973 schools were given access to the Internet (MoNE, 2008). In accordance with the large investments made on technology in

Turkey, reactions to technology within classrooms are worth investigating to understand the current situation.

2.1.1. Benefits of Technology in Education

Several benefits of technology in education were mentioned in the related literature. For instance, Roschelle and his collegues (2001) stated that there were several studies concerning computer-assisted instruction which highlighted the ways technology could support how children learned. It promotes four basic characteristics of learning which are: active engagement, participation, feedback and relation with real life situations. Moreover, some learning environments in which technology is used have specifically been presented recently. Computer Supported Collaborative Learning (CSCL) is one of those environments defined as educational settings in which computers and software are used to help in the instruction and assessment of both individual and collaborative learning tasks (Gress et al. 2010). Collaborative technologies are defined as technologies which are designed to enhance teamwork and interactions between students (Marjanovic 1999). Thus, CSCL could improve academic performance of students. Prinsen et al. (2009) found that students participating in a CSCL program communicate with their peers longer and send more detailed messages to each other. In another study, it was found that problem solving skills, critical thinking and written communication skills are fostered (Marjanovic 1999). Moreover enjoyment and motivation were enhanced in classrooms in which computer mediated communication software is used (Gomez et al., 2010). Similarly, a study by Tsai and Tsai (2010) revealed that students believe that PDAs (interactive tabletops) supports their learning more effectively and they indicated that they would be willing to use PDA if they had the chance to do so in schools. In addition to engagement, participation, feedback and real life situations, interaction among students are fostered by means of information and communication technologies. For example, the microworld Winlogo enables students to discuss and to select the most appropriate action for applying the given mathematical command.

In addition, higher order thinking skills, which enable students to improve their level of achievement in lessons, are one of the aspects of learning. These skills could be improved by means of using technology in instructions (Hopson, Simms& Knezek, 2001). Dede (1990) determined conditions where higher order thinking skills could be accomplished by students. Those conditions were identified as follows: learners construct their knowledge, they test and build hypotheses, they interact with their friends and evaluation is based on complex performance of students (Dede, 1990). Computers or educational software have potential to create a learning environment in which those conditions could be satisfied.

When active engagement, participation, feedback and relation with real life situations, higher order thinking skills and motivation are ensured by technology based instructions, students' achievement in lessons is improved. Several studies indicate that computers and software increase student achievement (Olkun, Altun& Smith, 2005; Li& Ma, 2010). According to a study by Sweet and Meates (2004), achievements of low achievers who are likely to be located in schools in which principals report that learning is hindered by lack of computers for instruction are investigated based on the PISA 2000 results. It was found that in Mexico, Brazil and France, low achievers were located in schools that had the fewest number of computers. It was found that in all OECD countries except Germany, low achievers felt less comfortable while using computers and had a lower level of self-confidence, whereas high achievers felt comfortable and had the competence to use computers in lessons. In order to enable low achievers to succeed in ICT and to reach a certain level of achievement in lessons by using technology, schools take into consideration the number of computers at school and at students' home. By enabling low achievers to have access to ICT access by guiding them about how to use technology in lessons to improve their level of achievement and by equipping them with ICT skills , it is possible to foster low achievers' learning process. In addition to the use of technology in schools, recent studies have also looked into the impact of students' computer use within their home environment on their level of achievement in their school lessons (Wittwer& Senkbeil, 2008). Although students use computers at home mainly for the purpose of entertainment rather than for educational purposes, any computer application, such as games, might have a positive effect on students' cognitive development (Delen& Bulut, 2011). By spending time with computers, children learn how to read and utilize information, concentrate on visual changes and achieve more in lessons (Subrahmanyam et al., 2001). For instance, Dumais (2009) stated that using the computer for entertainment purposes enables students to perform better in math.

Each student has his or her own typical way of learning and different interests. Students who have different learning styles could learn and perceive knowledge in their own way since their heredity, nurture and educational backgrounds differ. Thus, the traditional approach in education acts as a barrier to meet students' distinct needs (Shin et al., 2012). At that point, technology provides a great number of educational materials with multiple representations such as video, animation and simulation and tasks. Hence, the use of technology in learning tasks meets diverse individual needs and supports students' understanding with a variety of representations. As a result, each individual should have equal opportunity to learn concepts (Metin et al, 2012).

As mentioned above, the use of technology has many benefits for students, and teachers take advantage of using technology in education with respect to instruction, time and motivational support. Thus, technology takes part in the normal routine of the modern classroom in areas such as math and science (Comber et al., 2013). Since computers are basically mathematical machines, it is inevitable to discuss and investigate technology in mathematics teaching and learning (Laborde& Strase, 2010). Therefore, the role and importance of technology in math education is explained in following section.

2.1.2.. Technology in Mathematics Education

According to the National Council of Teachers of Mathematics (NCTM), which is one of the world's largest organizations in mathematics education, technology is accounted for one of six principles in school mathematics. Hence, technology has an impact on the teaching of mathematics and enhances learning of students. Therefore, NCTM (2000) insists on technology-supported school mathematics and declares:

> Technology is not a panacea. As with any teaching tool, it can be used well or poorly. Teachers should use technology to enhance their students' learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently and well — graphing, visualizing, and computing (p.25).

In accordance with this statement as claimed in the Principles and Standards for School Mathematics, students can learn mathematics more effectively with the appropriate use of technology (NCTM, 2000, p.25). In line with NCTM (2000), the Association of Mathematics Teacher Educators (AMTE) (2006), which is the largest professional organization devoted to mathematics teacher education with over 1000 members, supports the use of technology in schools as one of the principles of mathematics teaching. AMTE (2006) claims that the process of mathematical discovery, understanding and complicated connections can be facilitated via technology. Moreover, technology provides effective and diverse representation of mathematical topics, processes, and activities that make constructions of mathematical concepts and sense making easier. Therefore, instruction, students' understanding and teaching are facilitated and empowered by the use of technology.

In addition, The International Society for Technology in Education (ISTE, 2007, 2008), the Mathematical Association of America (MAA, 1991), the National Council for the Accreditation of Teacher Education (NCATE, 2002) and the Ministry of Education of Turkey (MONE, 2013) all encourage the use of technology in mathematics education since technology is regarded as an inseparable part of teaching and learning mathematics (NCTM, 2010, p. 24). Moreover, the general aim of the new Turkish 5^{th} to 8^{th} grade mathematics program states that effective use of information and communication technologies should be encouraged in elementary mathematics education.

In fact, in the past quarter of the century, educators have realized an extensive demand and growth in the use of technology in mathematics. Evolution of technology in math education has enabled researchers to investigate issues concerning how students learn mathematics and how to teach mathematics to them using technology (Goldenberg, 2000). It is believed that the use of technology enhances students' learning of mathematics (Forgasz, 2003). Therefore, a great number of researchers believe that technology supports conceptual understanding of students and, hence, should be integrated in mathematics lesson (Hollebrands, 2003).

In the literature, there are two recent theoretical developments concerning students' reactions to tools and the nature of the relationship between users, tools and understanding of concepts. First, the cultural-historical activity theory developed by Enström and his collegues concerns the activity system related with the interaction of the tool, user, task and the social context stand (Engeström et al., 1999). Therefore, this activity system yields explanations regarding the social stand of class and interactions between users. The second theory named the instrumental approach is similar to the former, while it differentiates from it in terms of the individual use of tools (Gravemeijer, 2005). This approach creates a distinction between the tool, such as geogebra, and the instrument consisting of the tool and cognitive instrumentation schemes. In other words, while dealing with the instrument, students develop cognitive schemes to understand conceptually and build knowledge about the use of tools. Artigue (2002) and her collegues have proposed the term 'instrumental genesis' to explain and describe the process of those students' cognitive schemes and the function of technological tools while using technology. This theoretical discourse is sought to identify the relationships between artefacts, technological tools, and users' cognitive processes, and it utilizes conceptual understanding of users (Laborde & Strasser, 2010; Drijvers, 2012). The process of those schemes developed by users is bidirectional: the tool influences students' learning process and students' actions influence the use of the tools (Reed et al, 2010). As a result, the existence of tools in the learning environments could support conceptual understanding and tool mastery (Reed et al., 2010).

In line with the theory, in a study by Nwabueze (2004), it was discussed that technologies have power to shift mathematics education from procedural understanding to conceptual understanding and improves problem solving and reasoning thinking skills (Wittwer& Senkbeil, 2008). Besides, technology converts abstract mathematics concepts to a concrete and visualized format, and it becomes dynamic and interactive to increase relationships between the student way of thinking and mathematics (Lesh, 2007). Therefore, technology appears to be a 'thinking tool' which presents mathematics as a 'play' and enables concept building (Schaffer and Kaput, 1999).

Van deWalle (1998) summarized three changes in mathematics education which technology is responsible for. The first one is that some mathematics skills such as computations (e.g. long divison and algorithms) or some constructions have decreased in their level of priority. The second one is that conceptual understanding is well-established through technology use in mathematics. The last change is observed in some mathematics topics such as data analysis, suggesting that these topics are more available to students and teachers through the use of technology.

On the whole, mathematics educators investigate the benefits of technology with respect to achievement (Işıksal& Aşkar, 2005; Olkun, Altun& Smith, 2005), motivation, higher order thinking skills, attitude (Yousef, 1999), self-esteem, feedback, conceptual understanding, how students learn with technology (Bosco, 2004), which tools are appropriate for certain topics and perceptions of students and teachers about the use of technology in mathematics education (Forgasz, 2010; Jackson et al, 2013; Doğan 2012).

Most of the studies on the use of technology in math education have aimed to reveal the impact of technology on students' cognitive process, and, in turn, on their achievement in mathematics lesson (Reznichenko, 2007). Based on their findings, it has been concluded that the level of student achievement moderately increases with the use of technology in classrooms (Aşkar& Altun, 2005). For example, in Işıksal and Aşkar (2005) experimental study, the effect of spreadsheets and dynamic geometry software on students' achievement was examined. The results indicated that there was a significant mean difference among the achievement test scores of three groups of students who were treated in three distinct ways: the Autograph-based instruction, spreadsheet-based instruction and traditional instruction. The students in the Autograph group had higher scores than students in the traditional group. In conclusion, the findings of this study indicated an increase in students' level of achievement. It is not a surprising result since the use of spreadsheet Microsoft Excel gives students the opportunity to develop 'what if' type of thinking and is a medium for the construction and explorations of mathematical concepts (Olkun et al, 2005). Similarly, Lester (1996) designed an experimental study in which the participants were high school students. In this experimental group, Geometry's Sketchpad was used as a technological tool, while the control group was taught via traditional instruction. In addition to administering a pre-test and post-test, the researcher interviewed the students in the experimental group. The results of the study indicated that students who were taught via computer-assisted instruction scored higher in the post-test than those who were taught by means of traditional instruction (Lester, 1996). Based on the PISA 2009 study, Delen and Bulut (2011) found a significant difference between use of ICT and students' achievement level in Turkey.

There is vast evidence that technology not only increases students' level of achievement, but also enhances in-depth understanding of mathematical topics (Clements, 1999). Understanding how students use tools and how they understand mathematical concepts by using technology are critical issues to be investigated. A study by Hollebrands could be taken into account as a first attempt to develop a framework for analyzing students' understanding and how technological tools have an impact on students' understanding of geometry. Hollebrands (2003) investigated the use of the technological tool, the Geometry's Sketchpad, to explore the nature of students' understanding of geometric transformations - reflections, translations, dilations, and rotations anchoring their framework. Sixteen 10th grade students worked with the tool for a total of seven weeks. The data sources were students' worksheets, observations, and interview documents. The researcher analyzed data by characterizing students' understanding of geometric concepts and their methods to explore their geometrical representations. Elements of students' understanding were categorized into domains, variables and parameters, relationships and properties of transformations. Results of the study revealed that the use of technology promotes deeper understanding of concepts since students' reason about drawings and transformations, and at the end they could reason about properties and natures of transformations. Hollebrands (2003) suggested that with the use of technology, students' understanding of transformations were critical for promoting the improvement of deeper understanding of transformations as functions.

Technology in math education also enhances students' problem-solving skills and the ability to pose problems. For instance, in a study by Christou et al. (2003), how students solve problems by using technology and how technology impacts students' problem posing skills were explored. Similar to the findings of a study by Laborde and Straser (2010), the results revealed that technology creates a dynamic and visual learning environment and, hence, students can solve problems, check their solutions and receive feedback. Furthermore, while dragging and investigating changes in the features of the software, students were able to make generalizations, conjectures, and extend the problem. Finally, students found the chance to explore specific cases in the problem about vertex quadrilateral via technology. In addition to finding a solution to the problems, technology enhances real life application problems, which increases students' motivation and interest in solving the given problem (Adams &Hamms, 2008).

Technological tools also support the development of positive attitudes to mathematics and geometry (Boyraz, 2008; Ellighton 2004; McCulloch, 2009). A study by Ellighton (2003) examined 54 studies concerning the impact of technology on achievement and attitudes of precollege students. The results of the study results indicated that the attitudes of students toward mathematics had increased owing to the use of technology in mathematics lessons. On the other hand, Hull & Brovey (2004) explored the impacts of using dynamic geometry software on 68 ninth-grade students' levels of achievement in circles and their attitudes towards geometry. The results revealed no significant difference in student scores compared to the results from the previous year. Furthermore, it was also indicated that using technology did not significantly alter students' attitudes towards geometry.

As indicated in the mentioned studies, technology has a potential to increase students' levels of achievement, motivation, and higher order thinking skills. However, whether those benefits are achieved or not depends on teacher perspectives on the use of technology in mathematics education. In a study by Drijvers et al. (2010), the aim was to discover new teaching techniques which were generated by mathematics teachers while using technology and to investigate the relationships between teachers' views on mathematics instruction and the role of technology. Instrumental orchestration was used for guiding students' instrumental genesis. Data were collected by means of videotapes of 38 lessons taught by three teachers, questionnaires and interviews. Results of the study indicated that six orchestration types emerged. Discuss the screen, Spot and show and Sherpa at work orchestrations were seen as more student-centered orchestrations than the remaining three. The data indicated that the use of technology does not change teachers' regular habits and views. That is, teachers see technology in mathematics education through their own perspectives, which is merely in the traditional way.

Apart from teachers' perspectives on technology and teaching philosophy as an obstacle for integrating technology, Risser (2011) and Hoyles and Lagrange (2009) discussed debates regarding the use of technology in mathematics education. Despite the advent of technological tools to enhance students' understanding, problem-solving skills, and higher order thinking skills, some teachers and educator have negative dispositions toward using technology in mathematics lessons. Using technology such as calculators at early ages may weaken students' paper-and-pencil skills and deprive them of basic skills for higher level mathematics, and they may harm students' sense of numbers, their operation skills and the skills for thinking abstractly (Altun, 2011). Similarly, Wiest (2001) stated that using technology more frequently and for only drill and practice may decrease students' understanding. On the other hand, Risser (2011) explained that the number of articles analyzed is extremely small when compared to the number of articles existing in the field, and there are also a great number of articles which favour the use of technology in mathematics instruction. Hence there are many researchers and educators who believe in the effectiveness of technology in mathematics education (Joubert, 2012; Drijvers, 2012). To provide an in-depth understanding of the effectiveness of technology, which technological tools are used in mathematics education is explained under the next subheading.

2.1.3. Technological Tools in Mathematics Education

AMTE (2006) defines technological tools as "computers with appropriate mathematical software, internet and other digital resources, handheld computing tools and their extensions, and future and emerging forms of similar devices and applications." (p.1). Similarly, Ozel et al. (2008) summarized the educational technological tools as calculators, the interactive whiteboard, immediate response devices, computers, web-based applications used in K-12 mathematics classrooms and their effects on instruction and student learning. Those tools enable students to visualize mathematical terms, concepts and, as a result, it helps to construct learning (Zbiek, Heid, Blume & Dick, 2007). In particular, Mathematics Analysis Software (MAS), such as scientific calculators, graphic calculators, Computer Algebra Systems (CAS), lists and spreadsheets, statistical packages, geometry packages have commonly been used in many classrooms (Pierce& Ball, 2009) and Logo, Coypu, Cabri, Derive, Mathematica help students to solve and pose problems, to make analysis and to generalize. In addition, calculators are one of the essential technologies in mathematics classrooms that enhance student understanding (NCTM, 2000). Moreover, these devices are programmed before the instruction by means of the tools menu and display and, thus, they are used easily by students and teachers

(Baki, 2001). To summarize, computers, graphic calculators, interactive whiteboards, web-based applications, software (skill focused and open ended such as Logo and Spreadsheet), dynamic Mathematics/Geometry Software are all started to be used in classrooms, and their effectiveness in aspects of achievement, learning, teaching and affective are investigated (Baki, 2001; Forgasz, 2004; Koehler& Mishler, 2005; Lester 1996).

Computers are one of the most crucial tools in technologically-enhanced mathematics teaching environment. Baki (2001) stressed that computer-assisted instruction is a way of instruction in which teaching activities are performed by using computers to present knowledge and mathematical ideas in a more concrete and comprehensible way. Similarly, Borwein and Bailey (2003) stated that computers are a medium to discover new patterns and relationships, to use graphs expose mathematical principles, to make conjectures related with rules, theorems and properties, to solve problems, to make proof, to confirm or to test solutions.

Dynamic software, which has recently been investigated, is one of the technological tools that is a medium for higher order thinking skills. Particularly in the domain of geometry, there are studies on the impacts of using dynamic geometry on problem solving (Christou 2005), discovering and conjecturing (Habre, 2009), developing reasoning and proof abilities (Fahlberg-Stojanovska& Trifunov, 2010), and mostly on achievement (Almeqdadi, 2010; Ubuz, Üstün, Erbaş, 2009). Jones (2002) also reviewed a variety of studies on dynamic geometry software. The results of these studies also showed that dynamic geometry software can help students to explore, conjecture, construct and explain geometrical relationships.

Drawing geometric elements, such as lines, circles and point, is an opportunity for technology users to make correct constructions by dragging (Abdelfatah, 2011). By dragging in a DGE, students can explore vast variations of a shape given a certain set of construction constraints (Laborde, 1992). As a result, the software supports students in taking a step further when generalizing geometrical figure properties and when establishing geometrical proofs (Clements & Battista, 1992). Thus, DGEs encourage students to reach higher levels within Van Hiele levels. Moreover, in a study by Almeqdadi (2011), simulations presenting real life contexts were presented to students. Thus, students felt motivated to discover theorems, rules and conjectures and they felt determined to find a way to prove their drawings and conjectures (Abdelfatah, 2011). Similarly, Dynamic geometry environments, such as Geometer's Sketchpad and Cabri Geometry, which enable a semiotic mediation between the mathematical objects and students (Falcade et al., 2007), enable students to make conjecture and to generalize after testing the iterations of mathematical objects by dragging and clicking (Moreno-Armella et al, 2008), which enables students to better understand the given problem and concepts. While doing these iterations, students discover mathematical ideas based on their own individual speed and mathematical background (Pitta-Pantazi& Christou, 2009). Specifically, the results of the study of Wiest (2001) revealed that in some geometry concepts, such as interior angle sum of polygons, students were able to change shapes and notice changes in sum of the polygons while using Geometer's Sketchpad. Therefore, students could explore the sum of the interior angles of the polygons by experimenting and conjecturing (Wiest, 2001). Similarly, the results obtained in a study by Sinclair (2004) indicated that using Geometer's Sketchpad advances students in noticing geometric relationships, proving ideas and improving reasoning skills.

Similarly, Leong et al. (2002) explored the effect of geometric software on students' spatial abilities on their formation of conceptual ideas within the domain of transformation geometry. The Wheatley Spatial Ability Test was administered to two classes as pre- and post-tests. They found that there was an increase in the ability test scores, suggesting that there was an improvement in students' spatial ability. Similar results were obtained in a study by Güven's (2007). In addition, Güven (2007) found that in the students in the experimental group enjoyed the classroom activities, which were integrated with technology, more than those in the control group.

The calculator is another technological tool that has the potential to teach mathematical concepts by allowing students to experiment with numbers and check their solutions (Lee, 2006). The graphic calculator and software related with line and quadratic graphs are the earliest computer applications. These tools are utilized in translating symbolic statements into graphical representations and in building concepts by enhancing the discovery of relationships between symbolic and graphic representations (Ruthven, Deaney & Hennessy, 2009). Therefore, students improve higher order thinking skills such as critical thinking and reasoning. In connection with the graphic calculator, there are numerous studies on achievement and attitudes. For example, Heller (2006) explored the relationship between the use of the graphic calculator and levels of achievement of 9 to 11 graders. Heller found that using the graphic calculator increased students' levels of achievement measured by means of points scored in the standardized test.

Moreover, various studies reported the value of using an interactive whiteboard to increase student motivation for learning and student attention during lessons (Hall & Higgins, 2005), develop students' autonomy (Minor, LosikeSedimo, Reglin & Royster, 2013) and increase students' conceptual understanding (Holmes 2009). Moreover, Birişçi, Çalık and Uzun (2013) stressed that some teachers perceived that time is a drawback in using whiteboards; however, they claimed that students are more interested in subjects and they are more motivated in lessons. The Interactive Whiteboard (IWB) was referred to as an educational resource 'supporting software, websites, and school pads. In a study by Kaya, Akçakın and Bulut (2013), the impact of the interactive whiteboard on 10th grade students' achievement in transformation geometry, including symmetry, rotation, and translation, was investigated. The results of the study indicated that technology increased students' achievement. Apart from achievement, a study by Amolo and Dees (2007) attempted to explore the effects of IWBs on perceptions and learning experiences of 26 fifth-grade students. They were taught via an IWB for ten hours. Data regarding perceptions of students were collected through a 15-item questionnaire as well as observations and interviews. In this study conducted in the U.S., all students expressed favourable statements and agreed strongly with the positive items of the questionnaire. The post-intervention survey indicated that students had a positive opinion with respect to improvements in lessons and motivation, and also expressed that they enjoyed using the interactive whiteboard.

Merely making technology available does not guarantee the enhancement of students' learning and, in fact, there are other external factors that have an impact on the effective integration of technology. These factors could be pedagogical perspectives, attitudes of teachers and students and alternative assessment methods (Voogt, Knezek, Cox, Knezek & Brummelhuis, 2013). Since students' and teachers' willingness in the use of technology are crucial factors, particularly studies on the acceptance of technology has recently increased (Smarkola, 2007). The decision to accept technology or use technology is influenced by their attitudinal, cognitive and normative assessments of factors relating to technology, the society, the task and the context (Hu, Clark& Ma, 2003). Based on the attitudinal aspect, technology acceptance is greatly affected by the user's attitudes towards technology (Teo, 2006). Therefore, identifying the user's attitudes towards technology appears to be crucial to detect whether or not the user accepts to use technology and predicts the user's behaviors in relation to computers (Teo, 2008).

2.2. Attitude

The word 'attitude' was first used in domain of art (Allport, 1935). Although attitude has the longest history in educational studies, it is an ambiguous construct and is frequently used without being appropriately defined (Hannula, 2004). In the literature, there are many definitions of attitudes. According to Allport's early definition, attitude refers to "a mental or neural state of readiness, organized through experience, exerting a directive influence on the individual's response to all objects and situations to or dynamic which it is related" (Allport, 1935, p.810). Morover, Allport (1935) described aspects of attitude based on sixteen definitions of attitudes.

He proposed three aspects: a) readiness for favourable or unfavourable responses, b) that is formed by experiences and c) that is emerged in existence of an object, situation or person. Similar with this definition, it is defined as "the affect for or against psychological object" (Thurstone, 1931, p. 261). Even though the definition of attitude has changed over the years, all the definitions stress a positive or negative disposition towards an object or a psychological condition. For instance, Fishbein and Ajzen (1975) defined attitude as a learned tendency to react to the object in a positive or negative way. Recently, the MODE model (Motivation and Opportunity as Determinants of the attitude-behavior relation) has defined attitude as "an association in memory between an object and one's evaluation of it". It does not emphasize a positive or negative disposition towards an object, and defines the construct in a closed way. On the other hand, Aiken (2000) proposed a contemporary explanation, stating that "attitude is a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (p.248). In Aiken's definition, learned disposition is stressed rather than readiness and experiences. In the mentioned study, Aiken's definition of attitude was taken into consideration.

Although attitude has similar features with some constructs, such as interest, opinion, emotions, belief or value, it differs from them in some aspects. For example, unlike interest, attitude depends on moral judgement, and it is more general in its effects on reactions. In addition, individuals may not be aware of their attitudes, unlike their opinions (Aiken, 2000). Moreover, belief can be falsified with an external criterion while falsifying attitudes with a criterion is more difficult (Albarracin et al, 2005). McLeod (1992) established a distinction among emotions, attitudes and beliefs and identified emotions as "the most intense and least stable, beliefs as the most stable and least intense and attitudes as somewhere in between on both dimensions" (p.107). Furthermore, attitudes can change with a single or many experiences (Arslan, 2006). Therefore, attitude can be both stable and temporary. If one attitude is stable and strong, then their behaviours are in line with their attitudes (Olson& Fazio, 2009).

Based on definitions of attitude, one-, two- or three-component models of attitude have been proposed by many researchers. However, the three-component model is more widely accepted among the others (Joyce& Kirakowski, 2013). Researchers claim that attitude is multi-dimensional and consists of cognition, affect and action (Aiken, 2000): *Affect* refers to feelings and emotions, *behaviour* refers to intentions and statements about behaviours, and *cognition* corresponds to beliefs, knowledge structures and thoughts. On the other hand, Albarracin and his colleagues (2005) claim that cognitive, affective and behaviour have interactions with attitude rather than being components of attitude.

2.2.1. Attitudes towards Technology

Over the last 20 years, researchers and policy makers have shown great interest in investigating competencies and attitudes toward technology because this is a crucial factor in enhancing students learning and in making educational decisions (Knezek& Christensen, 2008). As a result, researchers have investigated computer attitudes to determine the relationship between the acceptance of computers and attitudes towards computers and the behaviors of users (Ajzen& Fishbein, 1977; Huang & Liaw, 2005). It has been found that a positive attitude towards computers is a predictor of the willingness to embrace new technologies in classsrooms. Moreover, some studies indicated that positive attitudes toward computers provide successful implementation of technology in the educational setting (Yıldıırm, 2000). In addition, understanding attitudes toward technology enables educators to improve students' learning and engagement (Teo, 2009). In other words if positive attitudes increase, students are able to develop computer skills that provide advantages in the educational process, such as problem-solving, tutoring, and immediate feedback (Teo, 2008).

Despite the fact that understanding attitudes serves several benefits, such as depicting students' behaviours in relation with technology and facilitating instruction and learning, a few instruments have been developed (Teo, 2010) to measure pupils' attitudes towards technology There are scales measuring the general attitude towards computers of teachers and pre-service teachers (Hogarty, Lang& Kromrey, 2003; Yavuz, 2008; Teo, 2010), undergraduate students (Morris et al., 2009), secondary students (Pierce, Stacey, Barkatsas, 2007; Tsai et al., 2001) and elementary students (Chou et al, 2009; Jones & Clarke, 1994). Moreover, there are scales measuring attitudes towards computer-assisted instruction (e.g. Aşkar, Yavuz& Köksal, 1991; Celik& Yeşilyurt, 2013; Kılıçoğlu & Aslan, 2002). Moreover, particularly there are scales attempting to measure the use of technology in mathematics education (Forgasz, 2003; Galbraith& Haines, 1998; Pierce et al., 2007). Dimensions of developed scales and the theoretical background during the process of developing items are explained in detail in the following section. Some of those scales are developed based on the definition of attitude and behaviour theory, while some of them are developed in an unstructured way.

2.2.2 Theory of Attitude

Based on the theory of reasoned action, a behavior can be predicted by a person's intention to perform the behavior. Behavioral intentions function as intention holder's attitude toward the behavior subjective norm (Ajzen & Fishbein, 1980). Attitude is considered as the function of the beliefs, and subjective norm is defined as the combination of what others think about behavior and motivations. Ajzen (1991) proposed a theory called 'theory of planned behavior' (TPB), which is an extension of the reasoned action theory. TPB has not commonly been used as a framework in educational studies (Pierce&Ball, 2009). In addition to attitude and subjective norm, the theory added the perceived control behavior as having influence on intention. Apart from these theories, the technology acceptance model (TAM) hypothesizes that intention is affected by attitude toward the use and perceived usefulness and perceived ease of use. Perceived usefulness and perceived ease of use have effects on one's attitude towards usage.

The tripartitetite (three-component) model of attitude and the theory of planned behaviour (Ajzen, 1988) present a base for the model proposed by Kay (1993), which is a theoretical framework used for measuring attitudes. Kay (1993) proposed four distinct dimensions of computer attitudes: affect (feelings), cognition (perception and information toward computer), conation or behavioral action (intentions and actions in relation to computers) and perceived-behavioral control (perceived ease or difficulty in using the computer). In the light of Fishbein and Ajzen’s (1975) attitude paradigm, Davis (1993) designed the technology acceptance model. In addition to Kay’s components, the technology acceptance model proposed by Davis (1993) also included usefulness (the degree on which the computer is perceived to be useful in one’s work), which has an impact on using computers. Based on those models, affect, cognition, behavioural and perceived usefulness is favoured in the current study.

2.2.3. Scales for Measuring Attitudes towards Computers

Since the 1970s, many scales have been developed to assess attitude towards technology/computer as reported in the literature. The commonly used Loyd and Gressard’s (1984) computer attitude scale (CAS) consists of three affective constructs: anxiety, confidence and liking. Then Loyd and Loyd (1985) added a new dimension, namely, usefulness, as the fourth dimension of the scale. Subsequently, Nickell and Pinto (1986) developed a 20-item computer attitude scale consisting of two dimensions: 12 of the items measure positive attitudes, whereas 8 of the items measure negative attitudes towards computers. The Bath Country Computer Attitudes Survey designed by Bear, Richards and Lancaster (1987) attempted to measure the attitudes of students from 4th grade to 12th grade towards computers and to determine, by means of two other instruments, which factors affected students’ attitudes, including students’ computer experience and usage, educational and career plans and the school subjects they liked. However, these scales are outdated and were developed based on an unstructured nature of attitude.

Since the attitude models are effective in predicting the level of acceptance and intention of users, studies anchoring within those components to guarantee an extensive measure of attitudes towards computer (Teo & Noyes, 2008) have recently appeared. For instance, Selwyn (1997) developed a scale with 21 items selected from other computer attitude scales to measure 16-19-year-old secondary students' attitudes towards computers within the attitude-behaviour framework. He examined four dimensions: affect attitudes towards computers, perceived usefulness of computers, perceived control of computers and behavioral attitudes towards computers. Although it is crucial to gain insights into the nature of computer attitudes and relationships of constructs, it seeks generic computer attitudes of older students. Similarly, Teo and Noyes' (2008) study sought to develop and validate a computer attitude scale intended for young students (CAMYS). The scale was piloted with 256 students aged 10-12. Nomological validity was established by correlating computer use and computer experience with the developed attitude scale. Finally, the 12 items adapted and developed from available scales were revised and the final scale consisted of three dimensions: perceived ease of use, affect towards computers (positive or negative) and perceived usefulness.

Recently, other instruments have been developed by Tsai et al, (2001) and Teo and Noyes (2008), which included constructs similar to those in the Selwyn scale. The latter scale was revalidated by Asıl, Teo & Noyes (2014) to measure younger (11-12 years old) students' attitudes. In this study, a major limitation was the use of double negatives, which may have confused students. Although those scales are developed based on the framework of attitude constructs (the attitude theory of Fishbein and Azjen, 1975), the items within the dimension of the usefulness of technology are related with the general advantages of computers. To illustrate, 'Computers help me organise my work better' is one of the items within this dimension. In addition to the items in those scales, the constructs are also parallel with aspects of attitude, which are affective, behavioral and cognitive. The affective aspect can be measured by means of the construct of liking computers and enjoyment. The perceived relevance of computers and usefulness of computers could be an operationalisation of the cognitive aspect of attitudes. Similarly, computer anxiety or self confidence in computer use could be an operationalisation of the behavioural aspect of attitude. For instance, Levine and Donita-Schmidt (1998) developed a questionnaire to measure students' attitudes towards computers. The scale consists of five constructs: computer self- confidence, attitudes towards computers as an educational tool, stereotypical attitudes, perception of computers as a tool for enjoyment, and importance of computers. In the scale, self confidence is used for the behavioural aspect of attitude.

Similarly, in a study by Jones and Clarke (1994), a computer attitude scale was developed along three dimensions of attitude: affect, cognition and behavior. However, items in the cognition dimension are no longer related with cognition; hence, Smalley et al. (2001) developed a new attitude scale building upon the work of Jones and Clarke. In the scale 15 items are related to the affect dimension, 10 of them are associated with the behaviour dimension and 12 items belong to the cognition dimension. Items within the cognition dimension of this scale is about computer usefulness in daily lives and what people do with computers, and behaviour items are about the use of computers.

Moreover, in a study by Morris et al., (2009), 254 undergraduate students were selected as participants to validate the scale called The Attitudes toward Computer Usage Scale ATCUS. Its new dimensions are as follows: positive reaction, negative reactions, work/education applications and uses and social/recreation/shopping applications and uses. Although this scale reflects the nature of attitude, it is not related with the use of technology in the educational context.

Apart from scales related to attitudes towards technology, affective issues have an effective role in mathematics education (McLeod, 1992) because they are indicators of learning outcomes and predictors for future behaviours (Hannula, 2004). However, there is no clear picture for positive relationships between affective variables and achievement in mathematics (Hart, 1989). For example, in a study by

Barkatsas et al. (2009), results demonstrated that high achieving students as well as low achieving students in mathematics have positive attitudes to learning mathematics with technology. On the other hand, most of the recent studies on attitudes in mathematics education report a positive correlation between performance and attitude (Galbraith, 2006; Middleton, 1999). Hence, McLeod (1992) identified that attitude is one of the constructs which have been investigated in field of research on affect in mathematics. Moreover, if technology is a part of learning mathematics, there is a need to explore students' behaviours and attitudes towards computers (Asıl, Teo & Noyes, 2014) and their relation with mathematics. In the next section, attitudes towards technology in mathematics education and related scales are presented.

2.2.4. Scales of Attitude towards Technology in Mathematics Education

Since the use of technology has only recently taken its place in math curricula, specific attitudinal studies concerning mathematics seem to be inaccessible (Galbraith, 2006). However, it is a fact that the increasing use of technological tools in mathematics instruction articulate and stress the relevance of studying users' attitudes towards technology within mathematics education. In reported studies, it is difficult to evaluate the results of attitudes towards the use of technology in mathematics instruction since it is not clear whether reported affective outcomes are linked to changes in attitudes to mathematics or are associated with the technology. In order to distinguish the attitudes specific to the interaction of technology and mathematics, Galbraith and Haines (1998), for example, described attitudes and behaviours along the dimensions of confidence, motivation and engagement, and with regard to mathematics, computers and the interaction between computers and mathematics. The last mentioned attitude has a crucial impact on learning by means of mathematical computer tools. Findings of this study revealed that computer-mathematics interaction was more strongly related with the computer attitudes than mathematics attitudes. This finding is confirmed by studies of Fogarty and his friends (2001), Pierce and his colleagues (2007) and Forgasz (2003). This supports the reason why dimensions of computer attitude scales were selected instead of dimensions of mathematics attitude scales in the current study.

Apart from the general computer attitude scales, there are scales concerning attitudes towards the use of technology specifically in mathematics education. Particularly, Galbraith et al. (1998) and Pierce et al. (2007) developed a scale to measure attitude towards mathematics and technology interaction. The items in the scale developed by Galbraith et al. (1998) are related with the importance of technology for students in terms of providing several examples and constructing a relationship between algebra and geometry. Moreover, there are items related with the hazards of technology, such as difficulty in learning mathematical concepts when technology is used, distraction of using technology and no written documents provided. Furthermore, Pierce et al. (2007) developed a 27-item scale called Mathematics and Technology Attitude Scale, which consisted of five subscales: mathematical confidence [MC], confidence with technology [TC], attitude to learning mathematics with technology (whether they are computers, graphics calculators or computer algebra systems) [MT], affective engagement [AE] and behavioural engagement [BE]. This scale focused broadly on interest and efficiency in mathematics education without more complex and specific reflections. In the subscales of MC, TC, MT and AE, the Likert type format was used. In the subscale of BE, the frequencies of the occurrence of certain behaviours were asked to students. There are four items related to the benefits of technology and enjoyment within the subscale of MT. The items are associated with aim of the current study; however, the number of items is insufficient and the scale lacks some benefits of technology in mathematics education.

Moreover, in a study by Vale and Leder (2004), an 11-item attitude scale was developed called Attitude to Computer-based Mathematics Scale. The items in this scale are about the general advantage or disadvantage of using technology in math. Attitude to Computer-based Mathematics is defined as “the degree to which students perceive that the use of computers in mathematics provides relevance for mathematics aids their learning of mathematics and contributes to their achievement in mathematics" (p. 291). However, the scale does not include any item related to students' emotions and behaviors towards use of technology in math.

Although these scales and measures have been considered to be of worth to enable researchers to gain insights into the nature of computer attitude scales and relationships of its construct, few of them are concerned with the attitudes of elementary students toward the use of technology in math education. Therefore, based on the attitude theory, there is a need for a scale measuring elementary students' attitudes towards technology specifically in math lessons. As Pierce et al., 2007 stated:

> …With substantial investment in providing information technology to assist in teaching and learning mathematics, it is important to monitor students' reaction and decide how best to use both forms of technology, the mathematics analysis tools and the real world interfaces (p. 286).

In addition to the need for a scale to measure students' attitudes towards use of technology in mathematics lessons, not only gender differences in attitudes towards mathematics have been investigated since nearly fifty years, but also gender differences in attitude towards technology use in mathematics lesson have been of interest (Pierce et al., 2007). Studies related to middle grade students' perspectives and attitudes towards use of technology in mathematics education and differences in their attitudes with respect to gender and grade level are presented in the section that follows.

2.2.5. Studies Related to Students' Perspectives and Attitudes towards Use of Technology in Mathematics Lessons

Students are crucial social constituents of educational settings and, hence, their perspectives are vital to frame activities performed in schools (Deaney et al., 2003). Research indicates that students in early ages are able to analyse and evaluate teaching methodologies related to their learning (McCallum et al., 2000). In order to evaluate weaknesses and strengths of technology in education, there is a need to determine students' opinions or views regarding use of technology. Hence, there are several studies which aimed at exploring students' perspectives on technology use in mathematics education.

For instance, Deaney, Ruthven and Hennesy (2003) investigated 8^{th}, 10^{th} and 12^{th} grade students' views of the use of ICT with respect to learning school subjects. Based on 27 interview findings, six themes emerged. These themes were as follows: tasks affected, refinement assisted, ambience altered, motivation changed, learning reshaped, teaching displaced. Students claimed that using technology enabled them to achieve tasks efficiently and accurately; they were able to refine their attempts, make explorations and experiments, and also got immediate feedback. Moreover, it was expressed that technology made lessons more fun, exciting, collaborative work with their friends was easily carried out and that ICT increased their motivation. Students also indicated the importance of teachers' guidance and supports while reshaping their learning. Finally, students declared that technology provided the opportunity to work independently, progress according to their own pace, they could engage in challenging tasks and also understand concepts by means of a dynamic representation, which are consistent with findings of studies by Hannafin (2001) and Işıksal and Aşkar (2005).

Several studies have revealed that students found educational environments where technology was used more enjoyable (Baser et al, 2012; Galbraith &Haines, 1998; Nguyen, Hsieh, Allen, 2006). Galbraith and Haines (1998), and Pemberton (1996) agreed that computer and web-based applications increased students' level of confidence, motivation, engagement, and interaction. For instance, Kutluca and Zengin (2011) conducted a case study with 23 tenth grade students to gather their opinions regarding the GeoGebra software. Data was collected by using GeoGebra workshops and seven open-ended questions. The results revealed that students found the mathematics lessons with GeoGebra to be providing better conceptual understanding and permanent learning by means of visual and dynamic figures. Moreover, students stated that the lessons with technology made the lessons enjoyable for them and they were more engaged in lessons. A similar study was conducted by Hannafin, Burruss and Little (2001). It examined roles of students and teachers in technologically-supported classrooms. In such classrooms dynamic geometry software and spreadsheets were used. 7^{th} grade students were allowed to use software to establish relationships between geometric shapes and figures. Data sources for the study were observations and interviews held with students and teachers. Findings revealed that two themes had emerged: issue of power and learning. The teacher stressed that in such an environment regulating technology was difficult although she was aware of the benefits of technology. On the other hand, students enjoyed the tasks, worked hard and were interested in mathematical ideas more when technology was used. Moreover, they felt that they learned the properties of geometric shapes and felt highly motivated in the task. Similarly, in an experimental study by Dix (1999), the first aim was to investigate differences between mathematics achievement of 8th grade students exposed traditional teaching methods and students exposed to computers, and the second aim was to explore students' motivation while using computers. Students' views in on using Geometer's Skechpad in topics of tessellations and angle sum in polygons were addressed to investigate students' motivation through interview and observations. Findings indicated that students were in agreement with the fact that computers made tasks easier, that they were more willing to study with computers, that computers were easy to manipulate and they were able to accomplish tasks independently, that they felt more positive towards mathematics when the computer was used. On the whole, the use of technology had a slightly positive impact on students' motivation. Similarly, interview results of Boyraz's (2008) study indicated that all of the elementary students participating in the study had positive beliefs regarding the usefulness of technology in education and conceptual understanding. Some of the students expressed that a dynamic learning environment develops their growth in learning geometry because students could manipulate and construct geometrical shapes dynamically, which makes mathematics more comprehensible. Moreover, students in Trt1 (student-centered) stated that their learning became permanent; they could individually understand concepts by discovery learning and engage more in lessons. Students in Trt2 (teacher-centered), however, expressed that dealing with hands-on activities rather than watching objects on the screen is more applicable and useful for learning mathematics. On the other hand, many students agreed that visuality helped them understand concepts; they enjoyed themselves and became more engaged. They also expressed that technology increased their level of motivation and made more interested and enthusiastic towards mathematics lessons. Most of the students declared that they felt comfortable while using the technology; however, two of the participants said that they felt uneasy. Moreover, only one student responded that using technology is not crucial in the mathematics classrooms.

Moreover, Hartley and Treagust (2014) examined 12th grade students' perceptions towards computer-assisted learning in their mathematics classrooms. Data sources were individual and group interview and an instrument called the Computer-Assisted Learning Environment Questionnaire. Learners indicated that they perceived use of technology in mathematics classroom in a positive way. Firstly, they claimed that they were engaged in mathematics tasks and activities more; secondly, they could deal with more problems with computers, and finally they considered that technology enabled them to assess their own learning and gave immediate feedback.

Similar to this study, the study of Yıldırım and Demir (2014) sought to determine 10th grade students' opinions about technology use in mathematics lessons and alternative measurement and evaluation. 20 hours of technology-assisted lessons were designed on the topic of Trigonometry. Computer, datashow, interactive board, web connection, and computer programmes (Geometer's Sketchpad, Geogebra, Graphical Analysis, Microsoft Office, Paint, NetOpSchool) were used in classrooms. With respect to assessment, alternative assessment instruments, such as the computerized diagnostic tree, the structured grid, the word association test, concept maps, projects, problem solving exercises, and technological assessment instruments were used. Results of the interview with students indicated that perceptions on their engagement in lessons, interests and achievement were altered in a positive way.

Students claimed that they found using alternative assessment techniques instead of traditional methods results in improvement in their educational achievement. Students mentioned that they were more engaged, more motivated in lessons and they learnt conceptually. Moreover, students asserted that technology saved time during the stages of problem solving, which is a similar finding with those reported in studies by Brown (2012) and Deaney, Ruthven and Hennesy (2003).

Based on students' perceptions, attitudes are investigated by some researchers. According to Reed et al., (2010a), while promoting learning with technological devices, attitudes of students are one of the factors that should be taken into consideration since students' attitudes towards technology use in mathematics have an impact on the degree to which learning objectives are accomplished. For instance, Pierce and Stacey (2004) indicated that students who have positive attitudes towards technology use in mathematics are able to establish conceptual understanding and explore theorems and rules in mathematics. On the other hand, negative attitudes towards technological tools in mathematics lessons cause students not to use the tools and to become less competent in using the tools to improve understanding of mathematical topics.

Several studies indicated that students have positive attitudes towards technology use and they liked and enjoyed using computers in mathematics lessons (Aydoğan, 2007). In the study conducted by Pierce and Ball (2009), most teachers believed that technology enabled students to be more motivated in and to enjoy their maths lessons. In addition, they believed that technology improved students' understanding and enabled students to study with real life situations. Most studies related with technology in mathematics report a positive attitude by students, based on data regarding teachers' perceptions(Vale& Leder, 2004). In another study, McCulloch (2011) aimed to investigate the relationship between local affect referring to changing states of emotions and graphic calculator use in problem solving. Six students in grades 9 to 12 were interviewed. It is an important study because feelings can lead to the use of technology in math problems and the tool has power to build positive emotions while solving problems. In other words, using technology shapes students' feelings and feelings lead users to succeed in using technology. Hence, it could be concluded that using technology sinstils positive feelings in students while they solve mathematics problems. Thus, with this study the conclusion that students have positive attitudes towards the use of technology in mathematics lesson could be arrived at.

Similarly, Reed et al. (2010b) investigated the degree to which students improved in understanding the concept of function predicted from students' attitudes towards mathematical computer tools and behaviours and relationships between attitudes, behaviors and learning outcomes. Participants of the study were 565 students from grades 7 and 8. The scale consisted of general attitude towards mathematics, attitude towards using computers in mathematics, and reflective and communicative behaviours. A standardized test was applied to students to determine their understanding of the concept of function. Results of the study showed that attitudes towards math and using computers in math together explain a difference of almost 3.4 points on a 10-point scale among students in understanding of the concept. An interesting result of that study was that students who had higher attitudes towards mathematical computer tools got lower scores from the function test. This result is explained by the 'interest reversal effect', and it was stated that the reason of this may be students prioritizing technical aspects of tools rather than conceptual understanding. For the second question of the study, authors found that behaviours associated with attitudes towards math and attitudes towards tools are different. Students who had higher attitudes towards mathematics demonstrated a positive disposition towards tool mastery. On the other hand, students who had higher attitudes towards tools had lower scores in the final test. The last finding of the study was that there was no association in self-reported behaviours and students' test results.

In addition to students' attitudes and reaction to technology in mathematics lessons, differences in students' gender and grade level is another critical issues to be researched. Vast numbers of studies have been conducted to demonstrate differences in students' computer attitudes with respect to gender and grade level. Those studies are provided under the next subheading.

2.2.6. Related Studies with Gender and Grade Level

Both psychologists and computer educators have been interested in the gender of technology users (Whitley, 1997). In spite of the attention devoted to gender equality in education, there is a huge gender gap concerning computer use, and several studies indicated that students' use of technology at schools and beliefs about use of technology in education differ by gender (Veikiri & Chronaki, 2008; Asıl, Teo& Noyes, 2014). In line with this, Whitley (1997) claimed that gender is a crucial variable in technology because computers, computer games and software are perceived as a male domain. Hence, gender differences in students' motivational beliefs regarding computers has been taken into consideration since it gives insight into how to decrease gender difference and understand decisions taken about their future careers related with technology.

In general, several studies indicate that female students have less positive views regarding their computer competence (Nelson& Cooper, 1997; Shashaani, 1994) and demonstrate less positive emotional reactions to the use of computers than male students. This could be due to lower confidence in using technology and less interest in technology (Veikiri & Chronaki, 2008). There are studies indicating that male students' attitudes are more positive than female students. For instance, an early study by Boser, Palmer and Daugherty (1998) aimed to investigate changes in 287 middle grade students' attitudes toward technology with respect to four teaching techniques: integrated, modular, problem solving and industrial arts. It also aimed to examine differences in female and male students' attitudes toward technology. The PATT-USA scale was administered as pre-test and post-test to collect data. Results of the study indicated that female students perceived technology to be less interesting and more difficult to use than boys. Boys believed that technology is for men while girls perceived that understanding the importance of technology is equal for men and women. A similar study was conducted by Veikiri and Chronaki (2008) with 340 fifth and sixth grade students, which aimed to examine gender differences in access and frequency of computer use outside schools and students' view of parental and peer support. To gather data, a self-reported questionnaire was used. In the first part of the questionnaire, students' experience with computers was asked and in its second part, Likert type questions addressed their computer self-efficacy, computer value beliefs and perceptions of parental and peer support. Similar to those reported in the study of Whitley (1997) and Tsai et al. (2001), the results of this study demonstrated that boys had more positive self-efficacy and value beliefs about computers than girls did. On the other hand, although girls appreciated the value of computers in education, they used computers less often when compared to boys. Similarly, Işıksal and Aşkar (2005) found that boys had higher computer self-efficacy levels and they were more enthusiastic than girls. In addition, Whitley (1997), Dix (1999) and Sharpe (2004) found that men held more positive computer-related attitudes and behaviour than girls. Although several studies indicated that girls had less positive attitudes towards technology than boys, the difference in gender is very slight (Meelissen, 2005).

On the other hand, the results of studies about gender differences in attitudes showed inconsistency (Whitney, 1997) despite several studies indicating that boys had more positive attitudes than girls. However, there are studies revealing no difference between girls and boys in their attitudes toward technology. For instance, Teo (2006), Lee (2010) and Bovee, Voogt and Meelissen (2007) mentioned that there was no difference in attitude scores of female and male students. On the other hand, there are studies whose results indicated that girls had more positive attitudes than boys (Alghazo, 2006; Kubiatko et al., 2011; Morgan, 2008). Overall, results of studies concerning gender differences in attitudes are conflicting and confusing (Kay, 2008).

Grade level is another important variable in the investigation of students' attitudes towards technology. There are few studies which investigate gender differences in attitudes with respect to grade level. One of them is a study by Kubiatko et al., (2011), whose finding is similar with that reported in a study of Balta and Duran (2015). It found that younger students had more positive attitudes than older high school students. However, there are also studies which favouring older students in terms of attitudes towards computers (Bozionelos, 2001).
To sum up, based on the results of those studies related students' general attitudes towards technology, there is no clear cut differences in attitudes towards technology favouring females or males and young or old students (Kubiatko et al,2011). In addition to attitudes of technology, concerning mathematics, affective factors and differences in female and male perceptions and attitudes towards mathematics have been investigated (e.g. Fennema & Sherman, 1977, 1978; Forgasz, 1995). For instance, Leder and Forgasz (2000) found that girls more likely find mathematics interesting and enjoyable, when compared with boys. However, considering the integration of technology in mathematics lessons, few studies are conducted to explore attitudes towards technology use in mathematics with respect to gender and grade level.

For instance, Dunham's (1991) study, in which 16 students were interviewed, it was found that female students demonstrated feeling of guilt after using the graphic calculator. On the other hand, Dix (1999), in his experimental study, reported that boys developed more positive attitudes towards technology after using the Geometer's Sketchpad. Moreover, it was reported that boys had higher positive attitudes towards use of technology in mathematics lessons. Similarly, Leder and Forgasz (2000) found that boys were more likely to like the use of computers in mathematics than girls.

Moreover, the study of Barkatsas, Kasimatis and Gialamas (2009) sought to present complex relationships between confidence in mathematics, confidence in technology, attitude towards mathematics with technology, affective and behavioural engagement, and achievement. It also aimed to investigate any differences in those variables by gender and grade level. MTAS, consisting of confidence in mathematics confidence, confidence in technology, and attitude to learning mathematics with technology are positively associated with confidence in technology for boys. Overall, it could be inferred that high achieving male students are confident in using computers and have a more positive attitude to learning mathematics with technology than girls do. In addition, Pierce et al. (2007) administered the same scale (Mathematics and Technology Attitude Scale) in their study, and it was found male students were more confident than females regarding use of technology; however, this does not affect beliefs of students concerning the value of technology in mathematics education. Moreover, an important finding of the study was that a few girls expressed negative responses to items and girls' scores were not very low. In particular, the distribution graph of MT (Attitude to learning mathematics with technology) had a long tail for both girls and boys. Therefore, it was concluded that a large variability in MT scores of boys and girls was not explained by gender differences. As a result, authors recommended examining the reason of this variability in students' perception on effectiveness of technology.

In Vale and Leder (2004)'s study, the aim was to investigate forty nine 8^{th} and 9^{th} grade students' perceptions on and attitudes towards computer-based mathematics with respect to gender. In 9^{th} grade, students used Geometer's Sketcpad, Excel, Micro-worlds as educational technology and 8^{th} graders used Powerpoint and Excel in mathematics lessons. Three open-ended questions (e.g. What do you like most about using computers in math?) and closed- ended questions were asked to students. Based on the data obtained from the interviews held with students, three themes emerged: success (computers made mathematics easier or harder and enhanced learning), relevance (computer skills were learned) and power of technology (efficient or inefficient tool in mathematics). Girls viewed that technology enhanced their learning process in mathematics. If technology is beneficial in learning, girls have a more positive attitude towards use of technology in mathematics than boys. Although girls declared they enjoyed using computers, they presented that they have less enjoyed while using technology in mathematics learning when compared to boys. 84 percent of the boys believed that using computers in mathematics is a good idea, while 64 percent of girls believed in the same statement. Moreover, there was no significant difference between 8^{th} and 9^{th} graders' views about whether or not using technology in math is a good idea. According to the results of mean attitude scores, boys had more positive attitudes towards computer based mathematics instruction than girls did. Moreover 8^{th} grades had more positive attitudes than 9^{th} graders. Results of this study are consistent with the study of Forgasz (2002) and Vale (2005). Similarly, Forgasz, (2004) found that 7^{th} grade students had more positive attitudes towards the use of technology in mathematics than 8^{th}, 9^{th} and 10^{th} graders. However, it should be considered that in Vale and Leder's study, the sample size was quite small to make comparisons between students' attitudes with respect to gender and grade level.

In the experimental study of Nguyen, Hsieh and Allen (2006) with 74 seventh graders, a pre-survey and a post-survey were conducted. The pre-survey consisted of two parts: Attitude toward Mathematics and Attitude toward Computer Usage. The post-survey items consisted of 19 questions with 6 items on Attitude toward Mathematics, and 13 items on Attitude toward Web-Based Mathematic Learning and Assessment. MANOVA results indicated no significant difference between groups and no significant interaction between groups and gender. Based on the interview findings, all of the students, except one male, held positive attitudes toward using mathematics and computers in an integrated way. The male student stated: "I don't like computer math. I don't learn anything from the computer. Computers in math doesn't help and no relationships. It's difficult to work with the computer." Except the student who have negative attitude towards technology, students perceived that working with the computer made the learning process more enjoyable and appealing. Moreover, they believed that mathematics lessons became more colourful and reinforcing with more tables, charts and simulations. Males perceived that if they often work with computers, their achievement in math could be higher, and they enjoyed and liked the lessons with computers since it was challenging and enticing.

Furthermore they believed that computers provided more clues to solving questions, provided more knowledge and practice and they could receive immediate feedback to their answers. In addition, male students believed that mathematics became more enjoyable with technology and their motivation became higher. On the other hand, five female students all believed that computer-based mathematics instruction was much more interesting than paper-pencil mathematics since computers provide examples, information, scoring, and feedback while learning and reviewing the mathematical topics. One female student stated that her understanding of mathematical concepts such as fractions was improved through computers and could be able to solve problems step by step. In general, female students expressed their positive views and beliefs in the use of technology in mathematics education.

To sum up, especially gender differences in students’ attitudes towards technology in mathematics lesson are varied in different classrooms and school contexts (Forgasz and Leder, 1996) and there are few studies regarding grade level difference in students’ attitudes. In addition to these studies, related studies in the national literature are provided under the next subheading.

2.3. Summary of Reviewed Literature

Review of literature indicated that technology is an important part of education, specifically of mathematics education. In experimental studies, benefits of technology such as computers, graphic calculators, interactive whiteboards, web-based applications, softwares have been investigated with respect to achievement, motivation, higher order thinking skills and attitude towards mathematics (e.g. Ellighton, 2003; Graff& Lebens, 2007; Nwabuze, 2004; Wittwer& Senkbeil, 2008). Although technology is beneficial for teaching and learning, there are factors which have impact on effective integration of technology should be taken into consideration before releasing it in mathematics lessons.

Student engagement is one of these factors that have an impact on whether technology integration is effective or not. Fredricks, Blumenfeld and Paris (2004) introduced student engagement under three distinct categories: behavioural engagement, emotional engagement and cognitive engagement. In the use of technology emotional engagement refers to attitudes towards technology (Ainley et al., 2008), and one of the most significant indicators of affective and emotional readiness is attitude (Aiken, 2000). In mathematics education, attitude has been investigated in the research on affect (McLeod, 1992) because it is an indicator of learning outcomes and a predictor for future actions. Given importance on attitude, most of the experimental studies which revealed that students have positive tendency and attitudes towards technology in mathematics lessons (Hartley&Treagust; Boyraz, 2008; Dix 1999) have been conducted.

In order to measure students' attitudes towards technology in mathematics lessons, scales were developed (Galbraith& Haines, 1998; Pierce et. al, 2007; Vale& Leder, 2004). However, those scales have limited number of items related usefulness of technology in mathematics lessons and factors of the scales do not relied on three-model of attitude which is affect, cognition and behavior. As a result, there is a need for the scale to measure students' attitudes towards use of technology in mathematics lessons.

In addition to development of a scale, Teo and Noyes (2014) indicated that students' use of technology and beliefs about use of technology in education differ by gender and grade level is seem to appear another variable having effect on students' attitudes. Although, there are few studies related with gender and grade level difference in students' attitudes towards use of technology in mathematics lessons in the accessible literature, those studies indicated that there is no clear cut differences in among gender and grade level (Kubiatko et al., 2011).

CHAPTER 3

METHODOLOGY

This chapter represents research design and procedures conducted for this study containing seven subtopics which are the research design, population and sample, instruments, data collection procedure, data analysis procedure, internal and external validity, assumptions and limitations. On the whole, in this chapter, a general view of the methodology of the study is given to lighten the main idea of it.

3.1. Research Design of the Study

In literature, scales are about general attitude towards technology (e.g. Christensen and Knezek; Knezek and Miyashita, 1994; Loyd and Gressard 1984; Selwyn, 1997) rather than regarding the use of technology specifically in mathematics lesson. Hence in the current study the first aim was to develop reliable and valid attitude scale measuring elementary students' attitudes towards use of technology in mathematics lesson and second aim was to investigate elementary students' attitudes toward technology usage in mathematics lessons. According to Fraenkel and Wallen (2006) a cross sectional survey research is used to gather data via survey about specific characteristics of the sample in one time. With reference to this, cross sectional survey research was applied since this survey regarding technology usage in mathematics was applied to elementary students at once to get their opinions on a specific topic. Moreover, the study intended to explore differences in elementary students' attitudes toward technology usage in mathematics lessons with respect to gender and grade level. For that purpose, causal comparative research design was used for detect differences between two or more groups' characteristics (Fraenkel& Wallen, 2006) and discrepancies between female and male and also between 5th, 6th , 7th and 8th graders. It was concluded that, cross sectional survey and causal comparative research design were used to collect and analyze data.

3.2. The Population and Sampling

The target population of the study was entire elementary schools in Ankara where technology is being used in math classes. Accessible population of the study is all elementary schools where technology is being used in math classes in Çankaya district in Ankara.

One of sampling method is purposive sampling which participants are selected in accordance with specific aim of the study. With this sampling method, first, all key participants who have the specific characteristics are selected then, intention to determine the characteristics impacts are accomplished (Ritchie, Lewis, Elam, Tennant& Rahim, 2013). Before identifying schools as sample group it is asked to their mathematics teachers whether they use any technology in their lesson or not in accordance with the specific purpose of the study. Although many teachers believe in necessity of technology usage in education, a very few mathematics teachers use it for building students' conceptual understanding of mathematical topic. If teachers do not use technology in their mathematics lesson, students could not create an idea about benefits of technology usage in mathematics lesson. As a result it is not expected that exploration of attitudes of students towards technology usage is realistic and accurate. Therefore, purposive sampling method was used and participants were selected according to the criteria which is technology usage in mathematics lesson. After determining which schools are using technology in math classes, it is asked to whether they are willing to participate in the study or not by face to face meeting and telephone conversation. There are seven private schools and two public schools which are volunteers to participate in the study. Two private schools and one public school's elementary students were selected as participants of the pilot study and remaining five private schools and one public school's elementary students were participants of the main study. The next section provides detailed information about sample characteristics of the pilot and main study.

3.2.1. Pilot Study's Participants

Technology Usage in Mathematics Lessons Attitude (TMLA) Scale was administered to 234 elementary students in two private and one public school in Çankaya district in Ankara. Those two private and one public school from accessible population which are convenient to contact and easy transportation for researcher were selected and those schools are selected by taking into consideration of participation of at one public school for equalizing types of participating schools in pilot and main study. 46 percent of students were male and 54 percent of students were female in the pilot study. Detailed information about number of students with respect grade level is provided in Table 1.

Table 1

Demographic Information of Respondents with respect to Grade Level

	5^{th} Grade		6^{th} Grade		7^{th} Grade		8^{th} Grade	
	N	%	N	%	N	%	N	%
Students	88	37	39	16	23	10	84	35

According to Table 1, most of the students were at 5^{th} and 8^{th} grade. Ninety percent of students stated that they use smart board in the mathematics lesson and eighty percent of the participants specified that they use projector in the mathematics lesson. Inspite of few usages of Morpa Campus and calculator in mathematics lesson the table indicated that dynamic software programs were used for mathematics lesson moderately and frequency of the technological devices used in mathematics lesson is specified by the nearly same number of female and male students. Furthermore, operation with integers (addition, subtraction), angles of triangles, quadrilaterals, prism expansion, pyramid, cone, cylinders, exponential numbers, fractals, patterns, transformations, symmetry, trigonometry, coordinate system, equations, fractions, percent, length measurement, rational numbers, ratio and algebraic expressions are prominent mathematical topics which those are taught with technology. These statistics identified that participating students in those elementary schools learn or practice mathematics with technological devices.

In addition, all 7th graders and ninety four percent of 8th graders claimed to use projector in mathematics lessons whereas calculator is mostly used by 5th graders. Computers are one of the technological devices which are the most used by all graders. In 7th grade, video, smart board and software is least used technological tools while Morpa Campus is used most in 7th grade. Moreover, 5th graders pointed that they use softwares mostly in lessons comparing to other technological devices.

3.2.2. Main Study's Participants

Similar to pilot study data collection process Technology Usage in Mathematics Lessons Attitude (TMLA) Scale was administrated 571 (five hundred seventy one) elementary students from five private and one public school in Çankaya in Ankara based on determined criteria. Detailed information about elementary students' grade level regarding gender and school type is provided in Table 2.

Table 2

Demographic Information of Respondents with respect to Grade Level, Gender and School Type

Elementary	Female		Male		Public		Private		Total	
Students	N	%	N	%	N	%	N	%	N	%
5th Graders	105	18	87	15	14	2	178	31	192	34
6th Graders	68	11	68	12	16	2	120	21	136	24
7th Graders	36	6	34	6	-	-	70	12	70	12
8th Graders	88	15	85	15	-	-	173	30	173	30

As shown in Table 2, most of (thirty percent of) the elementary students are in the eighth grade and 5th grade. In addition to this, 70 7th graders were participated and 136 students participated as 6th graders. Furthermore there were 297 (52%) female students and 274 (48%) male students participating in the current study. All of 7th grade and 8th grade students and majority number of students in 5th and 6th grade were from private schools. However, only 14 students from 5th graders and 15 students from 6th graders were selected from public school.

In the first part of TMLA Scale, it was asked that which technologies are used in their mathematics lesson which is presented in Table 3 and which mathematical topic those technologies are used. Their responds to first question are indicated in Table 3.

Table 3

Information about Technology Used by Schools Participated in Pilot Study with respect to Grade Level

Technology	5th Grade		6th Grade		7th Grade		8th Grade		Total	
	N	%	N	%	N	%	N	%	N	%
Projector	146	77.2	120	93.8	77	95.1	166	96	509	89
Calculator	17	9	17	13.3	23	28.4	75	43.4	132	23
Morpa Campus	91	48.1	72	56.3	47	58	72	41.6	282	49
Computer	156	82.5	121	94.5	79	97.5	166	96	522	91
Video	104	55	79	61.7	57	70.4	108	62.4	348	61
Smart Board	87	46	78	60.9	55	67.9	145	83.2	365	64
Softwares-geogebra	116	61.4	26	20.3	56	69.1	11	64.2	309	54

Based on Table 3, students stated that in mathematics lesson the most used technologies are computer and projector. Almost half of students specified that software such as geogebra, video, smart board and Morpa campus are used at their schools. Calculator is the least used one of technological tools that is stated by participants and it is used more in 7th and 8th grade. More than sixty percent of students in 5th, 6th and 8th grade specified that they use Sofwares in their classrooms.

At which mathematics topics technology is used in the class was asked to students. Answers of students were following : operation with integers (addition, subtraction), angles of rectangles and triangles, prism expansion, pyramid, cone, cylinders, exponential numbers, fractals, transformations, coordinate system, equations, fractions, percent, length measurement, rational numbers, ratio and algebraic expressions are prominent mathematical topics which those are taught with technology. These statistics identified that participating students in those elementary schools learn or practice mathematics with technological devices that is similar with pilot study's result.

Moreover, according to results with respect to whether they use any technology for mathematics lesson at home, 310 (54%) students stated they use technology at home while 261 (46%) elementary students claimed that they do not use any technology at home for mathematics lesson.

3.3. Data Collection Instrument

Data was collected through Technology used in Mathematics Lesson Attitude Scale (TMLA). The attitude scale was developed to measure students' attitudes towards technology used in mathematics lesson. It was developed by the researcher considering of literature review about technology and mathematics attitude. Moreover the computer attitude scale developed by Loyd and Gressard (1984) was taken into consideration for identifying the factor structure.

The attitude scale was composed of two parts. In the first part of the scale there was demographic information of students including grade level, gender and technologies which are used in mathematics lesson. Moreover in which mathematics topic/s those technologies are used and whether they use of technology for learning mathematics at home or not were asked. Those questions were asked in order to analyse possible differences in elementary students' attitude scores in terms of gender, grade level and determine what technologies are being used and at which mathematical topic those technologies are used.

Second part of the scale consists of items related with attitude statements about liking, anxiety, self-confidence and usefulness/importance of technology in mathematics lesson. All the items aim to establish elementary students' attitudes toward technology using for mathematics lesson. While some item statements were positive, the others were negative. The scale consists of 40 items within 5-point scale where 1 represents 'Completely disagree', 2 represents 'Disagree', 3 represents 'Neutral', 4 represents 'Agree' and 5 represents 'Completely agree' with the item. Thus, the lowest score which can be achieved from the scale is 40 and the highest score which can be achieved from the scale is 200. Getting high scores in the scale refers to positive attitudes toward using technology in mathematics lesson and low scores refers to negative attitudes toward using technology in mathematics lesson. In the next subheading, how items were prepared is presented.

3.3.1. Preparation of the Scale Items

Items in the scale were constructed after detailed literature review about attitudes towards technology such as computers or smart board. To this end, ERIC, EBCOhost, and ULAKBIM which are databases are analysed for broad searching. Studies in those databases were examined thorough process of item writing.

In the literature, there are attitude scales concerning computer, technology, Internet, computer assisted instruction and technology and mathematics attitude scale which reviewed with respect to their items and constructs (Loyd& Gressard1984; Selwyn, 1997; Aydoğan, 2007; Aşkar, Yavuz& Köksal, 1991; Kneezek& Christensen, 1996; Pierce, Stacey& Barkatsas, 2007; Başer et al., 2012; Jones& Clarke, 1994; Tsai, Lin& Tsai, 2001). However in this study, the aim is more specific that the researcher aims to investigate attitude scale regarding the use of technology specifically in mathematics lesson than generic computer or technology. In other words, the scale intended to measure students' attitude was developed by considering combination of technology and mathematics rather than general technology. Therefore, items were adapted and developed in accordance with the purpose of the study.

Davis, Bagozzi, and Warshaw (1989) devised The Technology Acceptance Model (TAM) and expanded the TRA (Theory of Reasoned Action) (Ajzen& Fishbein, 1975) and TPB (Theory of Planned Behavior) (Ajzen& Madden, 1986) in order to measure technology attitude in different perspectives. Based on the Technology Acceptance model, attitude is defined as a favourable or unfavourable disposition towards an action, situation or object that parallel with attitude definition of Eagle and Chaiken (1993). Recently attitude appears to be multi-dimensional and consists of cognition, affect and action (Aiken, 2000). First, *affect* refers to feelings and emotions; second *behaviour* refers to intentions, statements about behaviours; third, *cognition* stands for beliefs, knowledge structures and thoughts. Based on theafore mentioned models, Kay (1992) claimed that constructs for assessing computer attitude involves *affect* (feelings towards computer), *cognition* (perceptions and information regarding computers), *conation or behavioural* (behavioural intentions and actions with respect to computers), *perceived behavioural control* (perceived ease, or difficulty, of using computers). . Moreover, in Davis, Bagozzi and Warshaw (1989)'s model *perceived usefulness* (the degree to which an individual believes using computers make improvement in their future careers or achievement) is identified as having impact on attitudes toward using technology. Grounding the scale within this framework based on attitude, these constructs become crucial to extensively measuring students' attitudes toward computers and developing valid attitude scales (Selwyn, 1997). Therefore, this framework was considered as a base for deciding on the constructs of the scale of attitudes towards use of technology in mathematics lessons.

In the computer attitude scale developed by Loyd and Gressard (1984); enjoyment, self-confidence, use of computers and anxiety were identified dimensions of the scale. Dimension of use of computers was relevant with construct of perceived usefulness in Kay's framework. Items under this dimension were concerning this statement that using computers will enhance students' future job performance and lives. However, in the current study construct of usefulness items were regarded to be relevant with the statement that using technology in mathematics lessons improves students' achievement or understanding mathematical concepts rather than using it for enhancing future careers. Hence, items under this dimension were not taken into consideration. Another scale developed by Knezek, Christensen and Myashita (1998) includes dimension of computer enjoyment, importance, motivation and persistence. Recently, Pierce, Stacey and Barkatsas (2007) developed the mathematics and technology attitudes scale which consists of subscales such as mathematics confidence, confidence with technology, attitude to learning mathematics with technology, affective engagement and behavioural engagement. Although there were items about usefulness of the use of technology in mathematics, most of them in the scale were separately related to technology and mathematics. Hence it was utilized from those scales considering the aim of the study. The reasons for selecting these scales are they have high reliability, and they include items related with affective, conative and behavioural dimension of attitude. Moreover, enjoyment, liking, and anxiety factors were chosen in construct of affective domain of attitude. In the literature, computer anxiety is sometimes given under the more general definition of computer attitude (King et al., 2002). Thus, anxiety factor was subsumed in the attitude scale. Furthermore confidence was considered for conative construct and importance or usefulness was considered for perceived usefulness constructs of attitude. In addition, in order to write the last factor which is perceived usefulness of usage of technology in mathematics lessons, item pool was created with the help of the literature. Finally, factors were formed as anxiety, confidence, liking and usefulness/importance and items were written based on those constructs.

Then, those items were checked by one expert from the Department of Measurement and Assessment. After the examination, some items were revised and deleted. Aa a result, in the scale 10 items were related to “liking” construct , 10 items were about “anxiety” construct, 7 items were related to construct of ”self-confidence” and 13 items were about ’’usefulness’’ construct. The scale consists of 40 items within 5-point scale. All the items aim to establish elementary students’ attitudes toward use of technology in mathematics lesson. To this end, in the 5-point scale, 1 represents ‘Strongly disagree’ and 5 represent ‘Strongly agree’ with the item. Following the item check, the scale was piloted with two children from 5^{th} and 8^{th} grade through face to face interview. Based on the interview, some spelling mistakes were fixed, and slender appearance changes were applied. For the purpose of content validation, the instrument was sent to four experts to be evaluated. Two of the experts are from the Department of Mathematics Education and they have so many research studies about technology and technology education in mathematics. The other expert is from Department of Science Education and she has many research studies on attitudes. The other expert is from department of Measurement and Assessment and he has many studies about statistics and attitude scales. These experts were asked to assess the quality of each item, verify matching of items to the corresponding components, and provide further suggestions. Some items were revised in the light of experts’ opinion. For instance, Item 26, “I do not think that I can use technology in mathematics lesson”, was changed as “I cannot use technology in mathematics lessons” because the latter is more clear to students. Item 40” Using technology in mathematics lesson gives opportunity to test theorems, rules and properties” was changed as” Using technology in mathematics lesson help me to understand where theorems, rules and properties comes from” because the latter is more understandable for elementary students. Also, item 11 ‘Using technology in mathematics lesson increase communication with my friends’ was omitted because the item did not seem to reach the intended purpose. Moreover, explanatory notes were added in parentheses for item 37 and words like ‘a lot or lot’ were omitted. Sample items of the final version of the scale were given in Table 4.

Table 4

Sample Items from the TMLA Instrument

Item Number	Dimension	Sample Item
3	Liking	I would like to use technology in mathematics lessons.
13	Anxiety	I get anxious when technology is used in math lessons.
25	Self-Confidence	I cannot use technology in mathematics lessons.
35	Usefulness	Usage technology in mathematics lesson makes my understanding permanent (picture, voice, animation).

3.4. Data Collection Procedure

The data collection started after the necessary permissions were taken firstly from the Research Center for Applied Ethics ethical committee at Middle East Technical University and then from the Ministry of National Education. After the all necessary permissions were taken, a pilot study was conducted. According to the results of the pilot study data collection process for the main study was started. The data collection period started in December, 2014 and lasted until January, 2015. The instrument was administered in all participating schools for the main study by the researcher except in two schools. In those two schools, mathematics teachers administered the data collection process. However, the researcher gave necessary information to mathematics teachers about the study and informed them about the data collection procedures, and the instrument was delivered to these schools by the researcher. Data was collected at the beginning or the end of the mathematics lesson based on flow of mathematics lesson in their regular classrooms. Moreover, all participating students were informed about the aim of the study and how to fill in the scale. To make students feel comfortable and give honest and reliable answers to items and questions, it was ensured that their answers were not shared and graded and their personal identity was kept confidential. The instrument was conducted approximately in 20 minutes.

3.5. Data Analysis

The data was gathered through Technology used in Mathematics Lesson Attitude (TMLA) Questionnaire. For both descriptive and inferential analysis, SPSS22 was used. The demographic information of the participants was gathered through the first part of the questionnaire and analysed by using frequencies, percentages, mean, and standard deviations. In the second part of the questionnaire, there were items addressing attitudes towards the use of technology in math lessons. Those items were scored on a scale ranged from 1 to 5. After the reversing the negative items into positive, sum of the scores for each item presented the overall score for each participant. The maximum score received from the scale can be 200 (the most positive attitudes in the scale) and the minimum score can be 40 (the least positive attitude in the scale).

In order to analyse first research question which was to develop reliable and valid instrument, firstly, exploratory factor analysis was held via SPSS22 to determine factor structure of the instrument and secondly, confirmatory factor analysis LISREL 8.8 was used to confirming the factor model. Furthermore, in order to respond second research question which addressed to verify attitudes of elementary students towards technology usage in mathematics lesson, descriptive statistics techniques in SPSS22 such as mean scores, maximum-minimum values, percentages for alternatives of items and standard deviations were calculated. In addition, to examine the third and fourth research questions in the study which address whether attitudes differ in respect to gender and grade level respectively, independent-samples t tests and one-way ANOVA which are types of inferential statistics were used since the study is aimed to investigate the differences between the mean scores of two and three groups of people (Fraenkel& Wallen, 2011).

3.6. Internal Validity and External Validity

The term validity refers to the ‘appropriateness, meaningfulness, correctness, and usefulness of any inferences a researcher draws based on data obtained through the use of instrument’ (Fraenkel& Wallen, 2006, p.150). Internal and external validity are two basic validity types that should be examined. Hence the threats to internal and external validity were discussed under the two following subheadings.

3.6.1. Internal Validity

Fraenkel and Wallen (2011) stated that internal validity is ensured as “observed differences on the dependent variable are directly related to the independent variable and not due to some other unintended variable’ (p. 166). In the base of this definition, it could be possible that survey and causal comparative studies includes internal validity threats such as subject characteristics, mortality, location, instrumentation and instrument decay (Fraenkel& Wallen, 2006). These threats and procedures of eliminating or minimizing those were explained in detail below.

Subject characteristics threat refers to the effect of participants’ features in a study may cause individuals differing in their reactions or responses in an undesirable way (Fraenkel & Wallen, 2011). Although, compared groups did not have same characteristics, it could be said that in general they shared similar features. Female and male students have similar technology experiences in mathematics classrooms since both female and male students are in similar classrooms and take mathematics lesson in a standard way. Moreover, students in different grade take mathematics lesson in a standard way with technology. However, when elementary students’ technology usage experience level or students’ extraordinary interest in the technology were considered, it was possible that those have an influence on the attitudes. Hence this issue could be accepted as a limitation and the result of the study were discussed by taking consideration of this limitation.

Frankel and Wallen (2011) claimed that subjects may be lost during data collection process or participants fail to complete scale that is called mortality threat. In spite of the fact that, the instrument was applied at once in the studies which are the cross sectional survey, mortality could seem to appear a threat since there were elementary students who did not complete scale because of being tired, bored and unwilling to fill the scale. However, the percentage of those participants did not exceed ten percent. Even if it was so, this threat was eliminated through reaching as many participants as from both private and public school and the aim of the study was explained to the participants in detail before implementing to the scale and just volunteer students was asked to join the study. Hence mortality does not appear a threat for the current study.

Location threat is referred to as particular locations where data are collected can affect participants' answers as undesirable way (Fraenkel& Wallen, 2011). The location may be one of factor which changes responses of participants in the study because all participants did not fill the scale in same location. In spite of that, data was gathered in regular classrooms of elementary students for all participants. Since location was kept standard in data collection process, location did not cause a threat for the current study.

The last threat was instrumentation threat which consists of instrument decay, data collector characteristics and data collector bias (Fraenkel& Wallen, 2006). Firstly instrument decay addresses the alteration in the nature of the instrument which resulted in being tired of scorers (Fraenkel& Wallen, 2006). For this study, despite high number of items, used Likert type scale, it took at most 20 minutes to administer and also evaluation becomes easier. Thus, instrument decay is not seen as a threat for this study. Secondly, characteristics of the data collector is considered to have little effect on students' responses since the researcher herself collected the data from majority of participating schools which are four and she explained the purpose of the study, kindly responded to students' questions related with the questionnaire and she did not discuss about answers of items and questions with any participants; however in three schools, mathematics teacher administered the questionnaire, characteristics of teachers could have been a threat for this study. To eliminate this issue, before implementation of the questionnaire, how the data collection procedure is and how to interact with students were explained to teachers hence data collection process remain constant in each participating classrooms. Thirdly, data collector bias threat refers to data collectors distorting the data for a desired result unconsciously by data collectors (Fraenkel& Wallen, 2006). In the current study, since some mathematics teachers' attitudes or behaviours while implementing the scale might affect students' responses to items in the scale data collector bias could be appeared a threat. To handle this issue, purpose of the study was explained in detail and how to administer the scale in classrooms to teachers for guaranteeing all participating teachers behaviors and reactions standard in all schools.

3.6.2. External Validity

According to Frankel and Wallen (2011), external validity is defined as "to extent to which the results of a study can be generalized" (p.103). In this study, the target population was determined as all fifth, sixth, seventh, and eighth grade elementary students from both public and private schools where technology is used in mathematics lesson in Ankara. There were 25 districts in Ankara. Elementary students from schools where technology is used in mathematics lesson in Çankaya district was selected as sample. 571 elementary students participated in the study that could be considered as a large sample. Despite the fact that the number of participants would seem large enough, since purposive sampling as a sampling method was used, it was considered to create a threat for generalizability. For ensuring external validity for the studies which non-random sampling as a sampling method was used, Fraenkel and Wallen (2011) suggested to give characteristics of sample in detail and repeat the study with different groups in different conditions. Therefore in order to minimize the external validity threat, characteristics of the sample such as gender, grade level, and school type were provided in detail. Replication of the study with different sample in different situations was given a suggestion to ensure generalizability of the current study results. Moreover ecological generalizability was described as '… the degree to which results of the study can be extended to other settings or conditions' (Fraenkel and Wallen, 2011, p.105). The participants of this study were all graders from elementary schools where technology was used in mathematics lesson. Hence sample of the study had similar situations and type of technology used with the population. Considering this, ecological generalizability of the study was appropriate.

3.7. Limitations and Assumptions of the Study

It was assumed that all students in the study reflected their own opinions and they were not affected by their teachers, other students and the researcher. Therefore, no interaction between students and teachers and researcher were supposed a key to ensure reliable individual answers.

The researcher administered the questionnaire to students in all schools except three schools where teachers gathered data from students. Although at remaining other schools researcher did not administer the scales, teachers were informed purpose of the study and explained how to administer the questionnaire. Hence, it was assumed that similar data collection process was held in all participating schools.

Major limitation of the study was that non random sampling was used as sampling procedure. Based on this method, only suitable schools which provide predetermined characteristics of the sample were selected in accordance with the purpose of the study. As a result using non-random sampling method decreases the generalizability of observed results (Fraenkel & Wallen, 2011). To overcome this limitation, it is recommended to replicate this study with different sample.

CHAPTER 4

RESULTS

Aim of the study was that initially develop reliable and valid scale measuring 5th, 6th, 7th and 8th graders' attitudes towards technology usage in mathematics lesson. Second goal of the current study was that explore students' attitudes towards technology usage in mathematics lesson and as a final purpose, students' attitudes mean scores were compared with respect to gender and grade level. Based on those aims, data analysis results were presented in this section briefly. In detail, exploratory and confirmatory factor analysis of the instrument, descriptive analysis results for the data got from TMLAS (Technology Usage in Mathematics Lesson Scale), independent sample t-test and one-way ANOVA results for presenting difference between males and females students' and the graders' attitudes mean scores respectively are mentioned in this section.

4.1. Validity and Reliability Issues of the Data Collection Instruments

In the current study, TMLAS was developed by the researcher. On the purpose of determining this new instrument's common factors including several measures and whether predetermined factor structure fit an observed set of data, exploratory and confirmatory factor analysis are applied respectively (DeCoster, 1998). Hence, data taken from pilot study are analysed via exploratory factor analysis to establish factors and data taken from main study are analysed via confirmatory factor analysis to confirm predefined factor structure. Exploratory and confirmatory factor analysis results on scores taken from TMLAS were given in the next section.

4.1.1 Results of Exploratory Factor Analysis

Before applying exploratory factor analysis, assumptions of the analysis consisting of sample size, factorability of the correlation matrix, outliers among cases and linearity were checked (Tabachnick & Fidell, 2007). Concerning sample size, Tabachnick and Fidell (2007) determined a criterion entailing the number of participants should be at least five times of the number of items and Cattell (1978) recommends that this ratio should be in the range of 3 to 6. For the pilot study, 234 elementary students composed sample size of the study and the number of items was 40. Therefore it can be said that sample size assumption is assured. For identifying the factorability of correlation matrix in other words the strength of the inter correlations among the items Tabachnick and Fidell (2007) suggest that the correlation matrix should indicate at least .3 correlations, Bartlett's test of Sphericity should be significant at $p< .05$ and the Kaiser-Meyer-Olkin (KMO) value should be at least .6. The correlation matrix indicated that presence of correlation coefficients of .3 or more for many pairs of items. Barlett's test of Sphericity value (Chi-square=5981.683 and p= .0) was found to be statistically significant. KMO value was found .94 exceeding value of .6. Therefore, factorability of the correlation matrix assumption was assured. In reference to linearity assumption, since Pallant (2007) stated that adequate sample size ensure this assumption, there is no need to check this assumption. Lastly, considering outliers among cases assumption, outliers have not seen in the pilot data. As a result, those findings supports data taken from pilot study is appropriate for exploratory factor analysis.

After meeting factor analysis assumptions, how many components are extracted was investigated by using maximum likelihood analysis since this technique give best result for sample normally distributed (Costello & Osborne, 2005) and it fit to confirmatory factor analysis (Kline, 1993). Steven (2009) stated that since in most cases correlated factors are more reasonable by some researchers, oblique rotation is most appropriate to prefer. Considering this statement, as a rotation method oblique rotation (direct oblimin) was preferred.

Based on Kaiser's criteria (Kaiser, 1960) there are seven components which eigenvalues exceeds 1 as indicated in Table 5.

Table 5

Exploratory Factor Analysis Results Regarding Initial Eigenvalues

	Initial Eigenvalues		
Factor	Total	% of Variance	Cumulative %
1	16,325	39,818	39,818
2	3,236	7,894	47,711
3	1,447	3,529	51,240
4	1,351	3,294	54,534
5	1,191	2,904	57,439
6	1,046	2,550	59,989
7	1,028	2,507	62,496

Pallant (2007) recommended that looking scree plot is also important to decide how many factors to retain since Kaiser's criteria presented too many components. The scree plot is given in Figure 1.

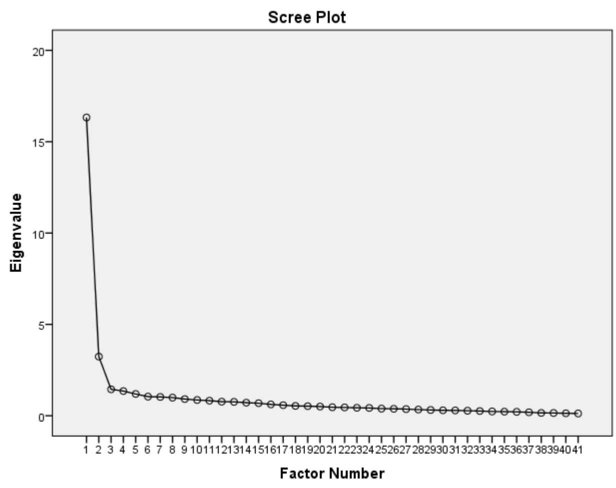


Figure 1 Scree plot of TMLAS

In the Figure 1, it can be said that there is a clear cut between second and third components and Stevens (2009) recommended that counting descending sharply components till they level off give number of retaining components. To gather more evidence to claim two factor structure, it is reasonable to refer Hakstian et al (1982) claim that accuracy of number of factors estimation is more reliable when the Q/P (where Q is the number of factors and P is the number of variables) ratio is less than .3. The ratio is below 0.3 as a result two factor structures for the scale were accepted. First component expresses 39 percent of variance while second component explains 9 percent of total variance. These two factors express 47 percent of total variance exceeding Klein's (1994) recommendation of at least 40 percent of total variance.

After deciding factor number, interpretation of items in each factors are made based on their communality values and factor loadings. When communality values of each item exceed .4, it is acceptable for the scale (Costello & Osborne, 2005). Based on the results of communality values most of communality of the items more than the recommended value except for the item 5, 6, 17, 26 and 32. Communality value of the item 26 and 32 are very close to .4 while 5 and 6 have very low communality values. Very low communality shows the variables are not connected with the other items in the set (Tabachnick& Fidell, 2001). In spite of being problematic items, Çokluk, Şekercioğlu and Büyüköztürk (2012) suggest to not give a decision as removing the item before the looking at their factor loadings. At that point Pallant (2007) and Stevens (2009) stated that minimum factor loading should be at least .3. However Hair and his collegues (2009) recommended determining significant factor loadings reference to sample size. Regarding sample size of the current study minimum factor loadings are determined as .4.

Moreover it is crucial to take into consideration of cross loading items to remove from the scale (Costello& Osborne, 2005). In the scale, all the items except for item 5 and 6 have higher loadings than .4. Hence items 5 and 6 were removed from the scale. These two removed items are presented in the Table 6. Furthermore, there is no item to load more than one factor. On the whole the scale consists of two factor structure.

Table 6

Removed Items in the TMLA Scale

Item Number	Item
5	It is difficult to give up studying with technology for mathematics lesson.
6	It is not necessary to use technology in mathematic lesson

18 items loaded one dimension while 20 items load second one. Those 18 items seem to measure positive emotional reaction to technology and usefulness of technology usage in mathematics lesson as a result this dimension named as ‘favor of technology usage in mathematics lesson’ while 20 items appears to represent negative emotional condition so it is named as ‘disfavor of technology usage in mathematics lesson. Pattern matrix of TMLA Scale items is presented in Appendix A.

For items which have low communality, some revision are applied to make items more understandable and to measure what is intended with the item and revised items were presented in Table 7.

Table 7

Revised items in TMLA Scale

Item	Item in The Pilot Study	Item After the Revision
18	Using technology help me in drawing figures.	Using technology help me to construct geometrical shapes (e.g. triangle, rectangle).
23	I am relaxed when technology is used in mathematics lessons.	I feel comfortable when technology is used in math classrooms.

	Table 7 (cont’d)	
27	I do <u>not</u> feel confident in use of technology in mathematics lesson.	I do <u>not</u> confide in learning how to use technology.
33	When technology is used, any mathematical topic become interesting.	Using technology changes boring mathematical topic into interesting.

After revision and deletion of some items final version of the items and their dimension is presented in Table 8.

Table 8

Final Version of TMLA Scale with Respect to Dimension and Item Number

Factors	Number of Items
Favor of technology Usage in Mathematics Lesson	1-2-3-4-5-6-11-15-18-19-25-26-27-28-30-31-34-36-37-38
Disfavor of technology Usage in Mathematics Lesson	7-8-9-10-12-13-14-16-17-20-21-21-23-24-29-32-33-35

Cronbach Alpha coefficient is .95 and .94 for subscales that indicates high internal consistency between items in the subscales (Pallant, 2007). After the analysis of pilot study, to test the factor structure, confirmatory factor analysis presenting strong evidence to ensure construct validity was used. Detail of confirmatory factor analysis of the study was given in the next section.

4.1.2. Results of Confirmatory Factor Analysis

Although exploratory factor analysis provides factor extraction, this method does not give factor loading of items on certain factor (Stevens, 2009). In order to test factors predetermined in exploratory factor analysis, confirmatory factor analysis is recommended to use for newly developed instruments. Stevens (2009) stated that confirmatory factor analysis allow to determine exact factor structure by means of specifying which variables load on which factor and correlation of factors. Confirmatory factors analysis result of TMLAS is given under the following sub section.

4.1.3. Confirmatory Factor Analysis Results of TMLAS

Based on exploratory factor analysis results two factor structure of TMLAS are determined. In order to confirm this factor structure and ensure construct validity confirmatory factor analysis was applied with data gathered from main study participants via LISREL 8.8 software program.

Items 1-2-3-4-5-6-11-15-18-19-25-26-27-28-30-31-34-36-37-38 were reunited in one dimension labelled as Favour of Technology Usage in Mathematics Lesson while item 7-8-9-10-12-13-14-16-17-20-21-21-23-24-29-32-33-35 load on the dimension named as Disfavour of Technology Usage in Mathematics Lesson based on hypothesize model. Hypothesized model for TMLAS based on confirmatory factor analysis results is given in Figure 2.

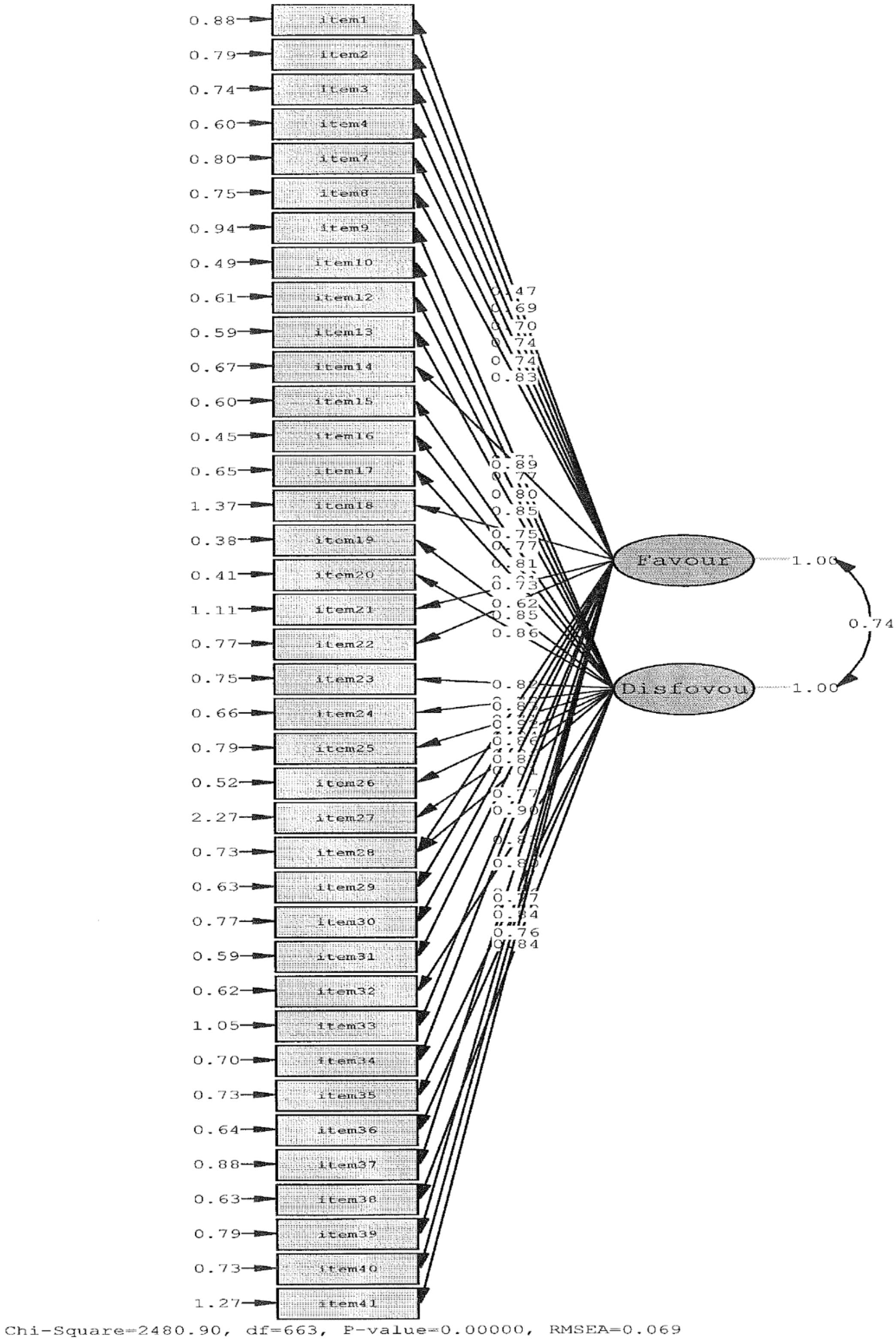


Figure 2 Hypothesized Model and Confirmatory Factor Analysis Results of TMLAS

Kelloway (1998) stated different fit indices are presented by researchers to assess their models whether fit or not with the hypothesized model. Absolute fit of the model and comparative fit of the model are commonly used for assessment. In the absolute model; alternate for the X^2 test some fit indices are proposed which are Root Mean Square Residual (RMR), Root Mean Square Error Estimation (RMSEA), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI) and relative/normed chi-square X^2/df (Gerbing and Anderson, 1992). RMR is defined as square root of the mean of the squared difference between applied and observed covariance matrices. Values of RMR are less than 0.05 considered as an indicator for good fit the data (Kelloway, 1998). Similar to RMR, RMSEA deals with residuals (Kelloway, 1998) and gives idea about parameters of model estimates fit the population (Byrne, 1998). Cut-off value of the RMSEA is admitted close to .06 or .07 (Steiger, 2007). Hooper, Coughlan and Mullen (2008) and Browne and Cudeck (1993) also indicated that in a well-fitting model reports value of RMSEA is recommended not exceeding .08. Moreover Kelloway (1998) defined GFI as ratio of the sum of the squared difference between variances and values of GFI 0.90 and more indicates good fit to the data. Tabachnick and Fidell (2007) defined as AGFI adjusting GFI with consideration on degrees of freedom. Relative/normed chi-square X^2/df is proportion of difference between the sample and covariance matrices which is fit (Hu and Bentler, 1999) to degrees of freedom. Ratio between 2 and 5 indicates good fit to the data (Kelloway, 1998; Wheaton et al, 1977). In the comparative fit of the model; Normed Fit Index (NFI), Nonnormed Fit Index (NNFI), Comparative Fit Index (CFI) and Relative Fit Index (RFI) were exposed. NFI defined as proportion of chi squares of difference between independence model and null model to independence model. Kelloway (1998) stated that this index indicates percentages exceeding the baseline independence model. NNFI is adjustment of NFI for degrees of freedom. Recommended value for those indices is at least .95 (Hu & Bentler 1999). CFI is extended form of NFI and sample size is regarded while calculating it (Byrne, 1998). It is recommended that CFI and RFI values should be more .90 (Kelloway, 1998).

Fit indexes offered by confirmatory factor analysis via LISREL 8.8 were investigated. RMSEA value is found 0.069 and normed chi square is calculated as 4.0 (2873.8/663). Moreover CFI and NNFI were both calculated as 0.97. Moreover NFI and RFI were both calculated as 0.96. Those values indicated factor structure is fit the data. In addition, GFI was found as 0.79 and AGFI was calculated as 0.77 which are lower than expected value.

Concerned with presenting internal consistencies, Cronbach alpha coefficient values were calculated for each dimension of the scale. Cronbach Alpha coefficients were calculated as 0.94 and 0.93 respectively for two dimensions of TMLAS. Cronbach Alpha coefficients of two dimensions are interpreted as quite high (Pallant, 2007).

4.2. Descriptive Analysis of TMLAS

Factor structure of the scale was established by exploratory factor analysis with the data got from pilot study and then confirmatory factor analysis was applied in order to confirm this factor structure. Revised and latest version of TMLAS was displayed in Appendix B. After ensuring factor structure, with descriptive statistics techniques data obtained from main study was analysed in order to investigate elementary students' attitudes towards technology usage in mathematics lesson. Result of the elementary students' attitudes is provided in the next sub section.

4.2.1. Attitudes of Elementary Students towards Usage Technology in Mathematics Lesson

Based on exploratory factor analysis and confirmatory factor analysis results, it was concluded that TMLAS composed of two dimensions named as Favor of technology Usage in Mathematics Lesson and Disfavor of technology Usage in Mathematics Lesson. The second research question which addressed elementary students' attitudes towards using technology in mathematics lesson was investigated through statistics such as mean values, standard deviations, skewness and kurtosis values. Five hundred and seventy-one elementary students (*N*=571) are responded to the attitude scale. Higher scores pointed out participants' positive attitudes towards using technology. Descriptive statistics output is given in Table 9.

Table 9

Descriptive Statistics for Attitude Scores

	N	Min	Max	Mean	SD	Skewness	Kurtosis
attitude	541	1.26	5.0	4.08	.73	-1.35	1.72

Table 9 indicates that the range of attitude scores is from 1.26 to 5.00, with a mean of 4.08 (*SD*= .73). The mean value of all items was found to be 4.08 that value is greater than 3-the midpoint of the scale out of 5 that can be considered as moderate. This moderate mean score indicates that elementary students have moderately positive attitude towards using technology in mathematics lesson. Moreover distribution of attitude scores is normal with based on skewness and kurtosis values.

For more deep and better understanding of elementary students' attitudes toward using technology in mathematics lesson descriptive statistics was calculated and interpreted for each dimension and is explained in the following two sub sections.

4.2.1.1. Attitudes regarding Favour of Use Technology in Mathematics Lesson

In Favor of Using Technology in Mathematics lesson dimension composed of 19 items. Those items are about positive tendency towards using technology in mathematics lesson, having confidence while using and positive beliefs about usefulness of technology in mathematics lesson. Mean score of the Favour of Using Technology in Mathematics lesson dimension was calculated as 3.90 out of 5 that is considered as moderately high. This moderately high mean presents elementary students have positive attitude towards using technology in mathematics lesson. To have detail insights about in which points students favour technology and how they perceive the use of technology, mean scores of each item in the first dimension is provided in Table 10.

Table 10

Mean Scores and Standard Deviation of Items in the First Dimension of TMLAS

Items	Mean	SD
1. I am self-confident while using technology in math	4.00	1.04
2. I am enjoyed while using technology in math	4.00	1.13
3. Using technology in math establishes permanent understanding since technology provides visually and audial (pictures, animations etc.)	4.00	1.10
4. I like using technology in math lessons	4.1	1.06
7. Using technology in math improve my math achievement	3.5	1.16
8. I find that using technology in math is interesting	3.7	1.19
14. Using technology improve my motivation towards math lesson	3.6	1.22
18. Using technology help me to construct geometrical shapes (e.g. triangle, rectangle)	3.5	1.39
21. I feel comfortable when technology is used in math classrooms	3.4	1.27
22. I am sure to use technology in math lessons	3.9	1.07
28. Using technologies in math enhance understanding of concepts such as altitude, and perimeter of circle.	3.7	1.19
29. Using technologies in math take my attention to the lesson.	3.8	1.21
30. Using technologies help me make long operations fast and accurate.	3.5	1.23
31. I like the use of technology in math	3.9	1.18
33. Using technology changes boring mathematical topic into interesting.	3.5	1.28
34. Using technology help me solve mathematical problems (organizing and analysing information)	3.6	1.23
37. Using technology provides me test solution of mathematics questions	3.5	1.23
39. I understand where theorems, rules and properties comes from when technology is used	3.5	1.19

Table 10 (cont'd)		
40. I can progress in my own pace while learning or doing exercises while using technology.	3.5	1.19
41. I feel that time is passing quickly while technology is used.	3.5	1.36

For each item in the first dimension, minimum value was represented as 1 while maximum value represented as 5. Hence for each item, it is possible to select positive or negative attitudes regarding favour of technology usage in mathematics lesson. However the mean score of items in the first dimension indicated that elementary students have moderately high attitudes regarding favour of technology. Almost all items mean score higher than 3.5 out of 5 which means that elementary students moderately have positive feelings and thoughts about technology usage in mathematics lesson regarding. With reference to student responses, liking technology usage in mathematics lesson appears to be the most prominently agreed attitude statement. Furthermore elementary students agreed with the attitude statements about being self-confident while using technology, being amused when technology is used, establishing permanent understanding since technology provides visually and audial (pictures, animations etc.), being sure of using technology and enjoying during usage of technology.

Attitudes of students on construct of usefulness of technology usage in mathematics lesson, they moderately agreed that it helps to draw some geometric shapes (for example: square, rectangle), to learn concepts (such as triangles, translation, rotation), to make long computation fast and correctly, to make mathematical topic more interesting, to solve problems (since technology organizes information and makes analysing easy), to test solutions of problems or questions, understand where theorems, rules and properties comes from and to progress their own pace while learning or doing exercises.

Participants addressed that using technology in mathematics increases their achievement and their motivation to mathematics. Moreover they agreed that while using technology in mathematics lesson they feel comfortable, technology takes their attention to mathematics lesson and they feel that time is passing quickly.

In consequence, although there are participants who have moderate mean scores for some items in the first dimension; overall mean scores for each item indicate that elementary students moderately highly agreed with favouring using technology in mathematics lesson.

4.2.1.2. Attitudes regarding Disfavour of Using Technology in Mathematics Lesson

In TMLAS, there are 18 items are about disfavour of using technology in mathematics lesson. Similarly to the items in the first dimension, items with a 5 point scale, where 1 corresponded to ‘completely disagree’ and 5 corresponded ‘completely agree’. The general mean score was calculated as 1.72 which indicated that Turkish elementary students did not agree that they perceived disfavour of using technology in mathematics lesson. To have detail insights about in which points students favour technology and how they perceive the use of technology, mean scores of each item in the first dimension is provided in Table 11.

Table 11

Mean Scores and Standard Deviation of Items in the Second Dimension of TMLAS

Items	Mean	SD
9. I could not solve mathematics problems by using technology.	1.92	1.20
10. When technology is used, I feel troubled.	1.58	1.05
12. When technology is used, I get anxious.	1.70	1.12
13. When technology is used, I feel uneasy.	1.68	1.14
15. When technology is used, I feel worry.	1.72	1.10
16. When technology is used, I feel get angry.	1.52	1.04
17. When technology is used, I feel destroying technology.	1.62	1.14
19. When technology is used, I feel uncomfortable.	1.58	1.04
20. When technology is used, I feel aggressive and hostile.	1.55	1.06

Table 11 (cont'd)		
23. I am willing to not listen to the math lesson, when technology is used.	1.83	1.21
24. I think that, use of technology is difficult to me.	1.70	1.12
25. I do not succeed in using technology in mathematics lesson.	1.70	1.14
26. When technology is used, I get bored.	1.75	1.18
27. I do not confide in learning how to use technology.	2.33	1.50
32. Using technology in math lessons is waste of time.	1.77	1.16
35. Use of technology in math lessons confuses my mind.	1.78	1.23
36. When technology is used, I feel frightened	1.55	1.09
38. Technology complicates my learning of mathematical concepts.	1.71	1.15

Elementary students did not agree that they could not solve problems by using technology, it is difficult to use technology, they did not succeed in using technology and they did not confide in learning to use technology. However, mean of the attitude statement, 'I do not confide in learning how to use technology', is 2.33 which closes to 3. Therefore, it is possible to claim that students have neutral agreement about feeling confidence about learning how to use technology in mathematics lessons. Moreover in respect to usefulness of technology in mathematics lesson participants did not agree that using technology is waste of time, using technology confuses their minds and it complicates learning of mathematical concepts.

Regarding use of technology in mathematics lesson, participants did not seem to agree that they get anxious, feel uncomfortable, worry, get angry, feel uneasy, feel aggressive and hostile, feel frightened and feel destroying technology. Moreover they did not agree that they get bored when using technology and are not willing to listening the lesson.

4.3. Gender Differences in Elementary Students' Attitudes

The difference of elementary students' attitudes in terms of gender was also investigated in the current study through the TMLAS. The information about participants' gender gathered through the scale ensured to compare students' attitudes with respect to gender. For investigating the difference between female and male elementary students' attitudes, independent samples t-test was applied since independent samples t-test provided comparing two mean scores of two different groups (Pallant, 2007).

4.3.1. Assumptions of Independent-Samples T-Test

Assumptions which are the level of measurement, random sampling, independence of observations, normality, and homogeneity of variance should be checked before conducting independent samples-t test (Pallant, 2011). The assumptions checked for scores of TMLAS were presented in the next subsections.

4.3.1.1. Level of Measurement

From the viewpoint of Pallant (2011), using continuous scale instead of discrete categories allows that dependent variable is measured at interval or ratio level. In the current study, to be able to determine gender differences in attitude scores, mean scores obtained from TMLAS were used as dependent variables which were continuous and measured at ratio level. Therefore, it was concluded that the assumption of level of measurement was assured.

4.3.1.2. Random Sampling

The assumption is required random sampling method. However in the current study, purposive sampling was used to determine participants. In other words, sample of the study which consisted of the students from elementary schools was selected based on their use of technology in math classrooms. Hence this assumption was not verified. However (Pallant 2011) stated that in a real-life research, it is difficult use of random sampling method. As a result, use of purposive sampling did not cause serious problems.

4.3.1.3. Independence of Observations

Another important assumption which is independence of observations is defined as observations or measurement which is not effected by any other factors and independent from those factors (Pallant, 2011). Data was collected from participants at once in mathematics classroom; therefore students' responses were not influenced by any other external factors and so, it is assumed that this assumption was verified.

4.3.1.4. Normality

Pallant (2011) suggested methods which are skewness and kurtosis values, histograms and normality plots and test of normality to assess normality. Pallant described skewness as the symmetry of distribution and kurtosis as the peakedness of the distribution. It was recommended that those values are between -1 and 1, however values between -2 and 2 are also acceptable to decide distribution is normal. Skewness and kurtosis values of female and male students on the mean score of their attitudes were examined. Skewness and kurtosis values are given in Table 12.

Table 12

Skewness and Kurtosis Values for TMLAS Mean Scores Regarding Gender

Groups	Skewness	Kurtosis
Female	-1.216	1.1
Male	-1.464	2.184

As shown in Table 12; skewness and kurtosis values of participants' mean attitude scores in terms of gender were between -2 and +2 except for male' s attitude mean scores' kurtosis value which was over the value +2. Both female and male elementary student's skewness value of mean attitude scores were less than zero which meant that there was negatively skewed distribution. This indicated that elementary male students' mean attitude scores did not verify perfect normal distribution. With reference to Pallant (2005) explanation which is that for large groups, skewness and kurtosis is not enough to check normality; therefore, histograms and normal Q-Q plots was used to identify normality assumption. All histograms and plots are presented in Appendix C. Histograms for the female and male participants' scores did not indicate normal distributions, however the normal Q-Q plots of female and male students indicated mean scores were plotted on reasonably straight lines. Lastly statistics tests were examined to assess normality. Although based on results of Kolmogorov-Smirnov statistics results, the Sig. value was found .00< .05, indicating violation of the normality assumption (Pallant, 2007), Pallant (2007) stated that with enough sample (more than 30), violation of this assumption did not lead serious problem to further statistical techniques. With this claim, it was concluded that independent samples t-test could be applied for comparing female and male elementary students' attitudes mean scores.

4.3.1.5. Homogeneity of Variances

Levene's test is applied for testing last assumption homogeneity of variances that is each group has same variances in scores (Pallant 2011). It was stated that significance value for Levene's test is greater than 0.05 meant that assumption of homogeneity of variances is not violated. Levene's test result was found as non-significant (.01< .05) for the mean scores of female and male students' attitudes hence same variation was not assured in attitude scores for the groups of female and male students. However, violation of the assumption is not barrier to conduct independent sample-t test (Pallant, 2007).

4.3.2. Research Question 3

Third research question of the study, gender differences in elementary students' attitudes toward technology usage in math was investigated in the current study. To be able to respond this research question, mean difference between female and male elementary students' attitude was explored through independent samples t-test, result of this test was provided in Table 13.

Table 13

Independent t-Test Result Regarding Gender

T-test for Equality of Means						
t	df	Sig.(2-tailed)	Mean Difference	Std.Error Difference	% 95 Confidence Interval of Difference	
					Lower	Upper
2.962	526	0.003	0.188	0.063	0.063	0.312

Independent samples t-tests result, given in Table 9, revealed that there was statistically mean difference between female elementary students and male students in terms of attitude towards technology scores ($t(526)=2.96$, $p= .00$). Therefore, it could be concluded that female students ($M=4.20$, $SD= .63$) have significantly higher positive attitudes towards technology usage in mathematics lesson when compared with males ($M=3.9$, $SD= .80$).

Eta squared calculated as 0.02 and interpreted as the magnitude of differences in TMLAS means is small (Cohen, 1988). It indicated that 2 percent of the variance in attitudes towards the use of technology is explained by gender (Pallant, 2007).

In conclusion, mean scores of female elementary students' attitudes is found as 4.2 with standard deviation of .63 whereas male elementary students' attitude is found as 3.9 with standard deviation of .80. In spite of high attitude of both female and male students, independent sample t-test result indicated that there is a significant mean difference between students' attitude in terms of gender in favouring of females. Hence it is possible to say that female elementary students perceive that the use of technology more useful in math lessons and feel more self-confident and enjoyed compared to male elementary students.

4.4. Grade Level Differences in Elementary Students' Attitudes

For testing difference between mean scores of elementary students with respect to grade level one way ANOVA was conducted since one-way ANOVA provided to compare three or more groups' mean scores on the dependent variable.

4.4.1. Assumptions of ANOVA

There are three main assumptions which are independence of observation, normality and homogeneity of variance that should be assured before conducting one-way ANOVA. First assumption independence of observation was mentioned before and it was assured since data taken from elementary students were not influenced any other factors while responding the scale. Second assumption is normality distribution of attitude scores for groups. As mentioned before in order to assess this assumption skewness and kurtosis values, histograms and normality plots and tests of normality results were analysed. Skewness and kurtosis values of mean attitude scores were presented in Table 14.

Table 14

Skewness and Kurtosis Values of Mean Attitude Scores of Grade Level

Group	Skewness	Kurtosis
5th Grade	-1.485	2.347
6th Grade	-1.245	.909
7th Grade	- .308	- .988
8th Grade	-1.368	2.088

As confirmed in Table 10, skewness values of elementary students' mean attitude scores were between -2 and 2 even there are two kurtosis values are higher than 2. However this could be tolerated by the normality tests. Only values of skewness and kurtosis are not enough to determine whether distribution is normal or not, in sample including large number of participants, histogram and Normal q-q plots should be checked (Pallant, 2007). All histograms and Q-Q plots are given Appendix D. Histograms for 5^{th}, 6^{th} and 8^{th} graders attitude scores did not demonstrate a normal distribution while 7^{th} graders attitude scores' distribution is normal based on histogram. On the other hand Normal q-q plots of graders indicated that mean scores of all grades were plotted on reasonably straight lines. Finally to assess normality, normality tests were examined. According to results of Kolmogorov-Smirnov statistics, the Sig. value was found less than .05, indicating violation in the normality assumption (Pallant, 2007). In large samples, Pallant stated that violation of normality is quite common and he suggests conducting statistical techniques in that situation. Therefore, ANOVA could be applied for comparing 5^{th}, 6^{th}, 7^{th} and 8^{th} graders' attitudes mean scores.

Third and the last assumption is homogeneity of variance. Levene's test is applied for testing last assumption homogeneity of variances that is each group has same variances in scores (Pallant 2011). Whether 5^{th}, 6^{th}, 7^{th} and 8^{th} graders have same variation in their attitude scores or not was assessed through Levene's test. Pallant (2005) stated that significant value more than alpha level implied that variance of the attitude scores across the graders was equal. Based on Levene's test result, it was concluded that assumption of homogeneity of variance across graders was violated because significant value is less than .05. Pallant (2007) recommends checking Welsh or Brown-Forsythe tests when the assumption is violated. Results of those tests are presented in Table 15.

Table 15

Robust Tests of Equality of Means

	Statistic[a]	df1	df2	Sig.
Welch	2,962	3	224,622	,033
Brown-Forsythe	2,320	3	459,266	,075

Using the Welch statistic, it was found that F ratio is significant ($F(3,224.622) = 2.962$, $p < .05$). Therefore, it is possible to proceed to ANOVA and compare students' attitudes mean scores regarding grade level.

4.4.2. Descriptive Statistics of ANOVA

Descriptive statistics of ANOVA presented the mean and standard deviation of 5^{th}, 6^{th}, 7^{th} and 8^{th} grade students' attitude scores. The summary of the descriptive statistics of ANOVA was provided in Table 16.

Table 16

Descriptive Statistics of Students' Attitude Scores Regarding Grade Level

Grade Level	Mean	Standard Deviation
5th Grade	4.13	.71
6th Grade	3.99	.82
7th Grade	4.26	.47
8th Grade	4.07	.72

Based on Table 16, it was seen that 7^{th} grade students have the highest mean scores (*M*= 4.26, *SD*= .47) in attitudes towards the use of technology in mathematics lesson while 6^{th} graders have the least mean attitude score (*M*= 3.99, *SD*= .82) when comparing students with respect to grade level.

4.4.3. Inferential Statistics of ANOVA

Fourth research question of the study, grade level differences in elementary students' attitudes toward technology usage in math was investigated in the current study. To answer this research question, one way-ANOVA was conducted and result of this test was provided in Table 17.

Table 17

One-way ANOVA Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,323	3	1,108	2,092	,100
Within Groups	280,712	530	,530		
Total	284,035	533			

As provided in Table 17, there was no statistically difference at the $p<.05$ level between attitude scores for students with respect to grade level: [F (3, 533) = 2.09, p=.05]. Therefore, it was concluded that elementary students' attitudes towards technology usage in math lessons did not alter across grade level.

CHAPTER V

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The current study sought to develop a valid and reliable scale to measure elementary students' attitudes towards the use of technology in mathematics lessons. Furthermore, it also aimed to determine, through the developed scale, elementary students' attitudes towards the use of technology in mathematics lessons. The final purpose of the study was to investigate whether gender and grade level influenced students' attitudes towards technology use in mathematics education. In this chapter, findings with reference to these purposes are discussed; in addition, implications and recommendations for educational practices are presented.

5.1. Validity and Reliability of TMLA

During the developmental process of the items in the Technology Use in Mathematics Lessons Scale (TMLAS), research studies on attitudes towards technology, such as computer, Internet and educational technologies were examined. Besides, the benefits of educational technologies on students' learning process, their level of achievement, understanding and motivation were investigated in detail. After this process, the items were evaluated by four experts. Two of these experts were from the Department of Mathematics Education and they had conducted numerous research studies on technology and technology education in mathematics. Another expert was from the Department of Science Education and had carried out numerous research studies on attitudes. The final expert was from the department of Measurement and Assessment and had performed numerous studies on statistics and attitude scales. These experts were asked to assess the quality of each item, verify the match between the items and the corresponding components, and provide further suggestions. Some items were revised in the light of the experts' opinions. All of these evaluations can be considered as powerful indicators of the construct validity of the scale (Crocker & Algina, 1986).

There seemed to be no specific scale in terms of elementary students' attitudes towards the use of technology in mathematics lessons in accessible literature; thus, items were generated based on the technology acceptance theory. Subsequently, as suggested in literature, to establish a factorial structure of the scale, an exploratory factor analysis was applied and then confirmed this predetermined factor structure of the scale through confirmatory factor analysis (Matsunaga, 2010; Pallant, 2007). At the end, the data taken from the pilot study of TMLAS were subject to exploratory factor analysis conducted by means of SPSS18, and confirmatory factor analysis was run using LISREL 8.8 with the data obtained in the main study Based on the exploratory factor analysis results, two factors named as 'in *favor of technology usage in mathematics lessons*' and '*against technology usage in mathematics lessons'* emerged. Before rotation (direct oblimin) of the axis, these two dimensions explained 48 percent of the total variance. This explained the value of variance which indicated the degree of power of the determined factor structure, and it is acceptable for social sciences (Çokluk, Şekercioğlu and Büyüköztürk, 2010). Pallant (2007) and Stevens (2009) stated that the minimum factor loading should be at least 0.30 for each item and cross loading for any items should not occur. For the items in the scale, factor loadings of all items were higher than 0.30 and there was no cross loading. Therefore, it is possible to say that all items had adequate associations in corresponding loaded on dimensions (Çokluk, Şekercioğlu and Büyüköztürk, 2010).

The accuracy of the hypothesized factor model produced by means of the exploratory factor analysis was tested and confirmed via the confirmatory factor analysis. The RMSEA value was calculated as 0.069, which is considered to be a good fit as it did not exceed 0.08 as recommended by Hooper, Coughlan and R.Mullen (2008) and was lower than 0.1 (Steiger, 1990). In addition, the normed chi square was calculated to be 4.0 (2873.8/663) within the range of 2 to 5, which could be interpreted as an evidence of a good fit (Klein, 2005). Moreover, CFI and NNFI were both calculated as 0.97, and NFI and RFI were both calculated as 0.96; these indices demonstrated that the tested model was a perfect fit (Hu & Bentler 1999; Kelloway, 1998). On the other hand, GFI was found to be 0.81 and AGFI was calculated as 0.77, which were lower than the expected values. The reason behind the low values of GFI and AGFI may be the large number of degrees of freedom when compared to the sample size in the current study. Therefore, it could be said that the increasing sample size would increase the value of GFI and AGFI because these two indices are sensitive to sample size (Sharma, Mukherjee, Kumar and Dillon, 2005). Although these indices are reported in studies based on the historical importance attached to them, (Hooper et al., 2008), Sharma, Mukherjee, Kumar and Dillon (2005) claim that GFI and AGFI have recently become less prominent and they suggest not using these indices while assessing the model fit of the data.

Finally, based on the exploratory and confirmatory factor analyses, it was concluded that the TMLA Scale was composed of two dimensions named 'in *favour of technology usage in mathematics lessons*' and '*against technology usage in mathematics lessons'.* In the first dimension, there are 18 items, while there are 20 items in the second dimension. The Cronbach alpha coefficient for the entire scale was found to be 0.96, which could be interpreted as indicating quite a high consistency (Pallant, 2007).

Constructs of the scale were determined based on the articulated definition of attitude, in relation with the multidimensionality of the attitude construct. Considering multidimensionality, attitude consists of three components: emotional, behaviour and cognition. The *enjoyment* and *anxiety* subscales are written based on emotional aspect of attitude, *self-confidence* is written based on the behavioural aspect of attitude and *usefulness* is related to the cognitive aspect of attitude. However, after the exploratory and confirmatory factor analysis, two dimensions were found to emerge in the developed scale. These two dimensions merely emerged as a positive or negative disposition toward the use of technology in mathematics education based on the simple definition of the attitude construct (McLeod, 1992) even though the items in the scale were written based on the emotional, cognitive and behavioural aspect of attitude. This inconsistent finding leads the researcher to evaluate the definitions and theoretical models of attitude. As a matter of fact, Fishbein and Ajzen (2010) suggest that ‘theory and measurement have converged on a unidimensional conception of attitude’. In other words, it is claimed that attitude is unidimensional and ranged between negative to positive. On the other hand, Eagly and Chaiken (2007) proposed that attitudes might be formed with one of any three types of processes; feelings, experiences and beliefs. Moreover, they stated that in attitude studies these three components might not be separated and that the three could even merge. Based on this definition, it could be inferred that two factors called in *favour of and against technology usage in mathematics lessons* include three aspects of the attitude model and definition of attitude and factors emerged associated with each other.

Another reason underlying the emergence of two distinct factors might be that students’ perceive the use of technology in mathematics education in a way that is either positive or negative. Hence, students have a general positive or negative tendency towards technology without unambiguous considerations of technology use in mathematics lessons. Students at their age may not be considering technology as tools in mathematics lessons and they may be evaluating technology in a simplistic way, as do so in their daily lives.

Another reason behind this might be the insufficient level in the expansion of technology use in Turkish mathematics lessons. Hence, attitude towards technology use in mathematics lessons may not be composed of distinct dimensions. A similar claim was made in a study by Berberoğlu and Çalıkoğlu (1991), in which it was found that attitudes towards the computer dimensions of the scale did not emerge, and the reason underlying this finding was that computers were not often used by participants.

5.2. Attitudes of Elementary Students towards the Use of Technology in Mathematics Lessons

Based on the descriptive analyses results, it was found that elementary students had a moderately positive attitude towards the use of technology in mathematics lessons because the mean value of all the items was found to be 4.08, which is greater than 3 - the midpoint of the scale out of 5, which can be considered as moderately high. This result seems to be consistent with the results of a study by Dündar and Akçayır (2014), which indicates that students' have positive attitudes towards the use of Tablet PCs. Similarly, Boyraz (2008) found that dynamic geometry based computer instruction has a positive impact on students' attitudes towards use of technology in mathematics lessons. In other words, when technology is applied in classrooms, students may develop positive attitudes towards technology and mathematics. Indeed, the results of most of the experimental studies revealed that students have positive attitudes towards it (e.g.Ursini and Sanches, 2008; Pierce, Stacey& Barkatsas, 2007; Aydoğan, 2007; Nguyen et al., 2006; Ursini, Sanchez& Orendai, 2004). The reason for the positive attitudes of middle grade students might be explained with the existence of an interesting learning environment created by technologies in the classrooms. This assumption is supported by the result of Boyraz (2008)'s study, which revealed that while students deal with computers, they enjoy the lessons more and are much more interested in mathematics lessons since a different learning environment from the traditional learning environment might raise students' awareness to lessons, which, in turn, results in positive attitudes towards technology.

More specifically, students' attitudes towards technology are consistent with the findings of other similar studies in the literature. For instance, students responded positively to attitude statements such as 'I like using technology in math lessons' and 'I am enjoyed while using technology in math' in the construct of *enjoyment,* which is mentioned in the literature (e.g. Pierce, Stacey and Barkatsas, 2007; Boyraz, 2008; Galbraith and Haines, 1998; Pilli and Aksu, 2013). Furthermore, in the construct of *usefulness*, students agreed moderately highly with statements, such that it helps to draw some geometric shapes (for example: square, rectangle), to learn concepts (such as triangles, translation, rotation), to make long computation fast and correctly, to make mathematical topics more interesting, to solve problems (since technology organizes information and makes analysing easy), to test solutions of problems or questions, and to establish permanent comprehension since technology enables both visual and audial (pictures, animations etc.) aids. These benefits of technology within mathematics education expressed by students support other findings in the related literature (e.g. Nguyen et al., 2006; Hartley& Treagust, 2014; Boyraz, 2008) in which students claimed that technology made mathematics more understandable and enables them to test their solutions to problems. In addition to these benefits, participants in the current study also maintained that using technology in mathematics increased their level of achievement and their motivation to mathematics. The reason why students moderately agreed with items in the usefulness construct shows students' acceptance of the importance of technology. In fact, technology is a medium to explore, conjecture, construct and explain mathematical relationships (Borwein and Bailey, 2003) since it presents mathematical knowledge in a more concrete and understandable way (Baki, 2001). Moreover, in technology rich environments, students have the opportunity to discuss and share their ideas, which enables students to be more active in their learning experience, which is different from traditional instruction. As a result, in this study they may have enjoyed the lessons and developed a positive tendency towards the use of technology in mathematics lessons.

Furthermore, participants did not seem to *agree* that they got anxious, felt uncomfortable, worried and were aggressive. On the other hand, they agreed with being confident while using technology. In terms of the constructs, they had a lower mean score in the constructs of *anxiety* (*M*=3.9) and *self-confidence (M=*3.9*)* than in the construct of *enjoyment (M=*4.3*)*. Actually, computer anxiety has a strong relationship with computer use (Kay, 2008). Items in the construct of self-confidence were written based on the behavioural aspect of attitude. Hence, students who use computers in mathematics lessons might feel self-confident and their anxiety level might decrease. Results indicated that the mean value of the construct of self-confidence was moderately higher than the midpoint of the scale, which indicated that students while students used technology, they felt moderately highly self-confident. In those classrooms, students may use technology adequately. Hence, they feel more confident and less anxious while using technology. On the other hand, interpretation of this result may be misleading since students with little experience in technology may have reasonable computer confidence (Galbraith& Haines, 1998). In that case, it might be inferred that students may have problems in engagement in technology in mathematics education. Even if students have positive attitudes towards technology, students may have problems in mathematical understanding (Galbraith, 2006) and tool mastery. In fact, the mean score of the construct of usefulness is 3.7, less than the mean score of the construct of enjoyment. This may provide insight into the relationship between students' positive attitudes in terms of enjoyment and their mathematical understanding with the use of technology. In such a situation, a lower mean might be an indicator that students experience some challenges while understanding ideas with the use of technology, regardless of their positive feelings towards it.

In a particular study of Reed et al., (2010), a negative relationship between conceptual understanding and attitudes towards mathematical tools was found. This relationship is explained by an *'interest reversal effect'* of computer tools on students. In this study, while students got high scores in the affect construct of attitude, they got moderately high scores in the cognitive and behavioural aspects of attitudes. It can be predicted from this finding that if students are taught a mathematical topic via technological tools, there could be a negative relationship between their scores on a test and their attitudes towards computer tools since students may have a tendency to prioritise technical aspects of computers over concept building (Reed et al., 2010; Pierce& Stacey, 2004). Thereby, the mere existence of technology in a classroom may take students' attention and they may display a high attitude towards it; however, they may not be able to grasp the mathematical idea behind the technology. In consideration of this, participants in the current study might have indicated a moderate degree of agreement in the items related to the construct of *usefulness (M=3.7)* when compared to the other items in the scale.

Moreover, one of the reasons of students' moderately positive attitudes towards use of technology in mathematics lessons could be their positive disposition towards technology in their personal lives. In relation to this point, Shook, Fazio and Eiser (2007) claimed that if students have no direct experience with the tools, they have the potential to generalise their attitudes from using technology for personal concerns to using it as a tool for learning mathematics. Therefore, students may reflect their personal tendency towards technology rather than indicating an actual attitude towards use of technology in mathematics lessons. As a result, in interpreting the positive attitude of students' towards technology, it is crucial to take into consideration whether or not attitude is predictive of behaviour. Another underlying reason why they possess positive attitudes could be the positive attitudes of their teachers towards technology in mathematics lessons, which is considered as a factor influencing students' attitudes towards technology since Frenzel et al. (2009) claimed that teachers may exhibit positive or negative beliefs and attitudes in their teaching, and students may adopt these attitudes as their own attitude. Moreover, Rowe (1993) stated that primary students view computers as a vital component in their education for their future careers. In accordance with this statement, the reason of moderately high attitudes of middle grade Turkish students might be students' positive perception of technology due to its importance for future careers.

5.3. Discussion on Findings related to Gender and Grade Level Differences

In the current study, it was found that girls had more positive attitudes towards technology use in mathematics lessons than boys although a small effect size was calculated. Unlike the current study, several studies indicated that generally boys have a more positive attitudes towards technology than girls do (Ursini & Sanchez, 2008; Dix,1999; Vale & Leder, 2004; Jackson et al., 2013), and boys have higher scores than girls with respect to computer self-efficacy (Işıksal& Aşkar, 2005). For example, in the study of Christensen, Knezek and Overall (2005), it was found that in sixth grade, boys began to hold more positive attitudes than girls did. Moreover, Forgasz (2002) reported that students perceived technology as a male domain. Hence, girls are more likely to develop a view that technology is difficult to use and to understand than boys (Boser et al., 1998). In addition to studies favouring boys in terms of attitudes, there are also studies which demonstrate no gender differences in computer attitudes (Dündar and Akçayır (2014); Loyd and Gressard, 1987; Altun et al. 2004; Aşkar, Yavuz, Köksal, 1991). The reason behind the inconsistency of the results of these studies with those of the current study might be that the difference in the sample groups; while those studies consisted of secondary school students, the current study was conducted with middle grade students, and most of the studies favouring boys are outdated. In addition to differences in the sample, it was revealed in past studies that male students possessed more computers and they were more interested in technology (Ordidge, 1997); thus, their attitudes towards technology were more positive than those of female students. However, recently technology has become a vital element for daily life and future career, and, thus, female and male students' attitudes and preferences towards technology have severely been influenced (Thompson, 2013). Hence, it was claimed that the gap between female and male students were closing in terms of their familiarity with computers and the amount of experience with computers (Dündar& Akçayır, 2014). Moreover, although there are studies revealing that males have a higher level of technical competence in computers than girls (Kubiatko et al., 2011), when technology is used specifically in mathematics lessons, this difference becomes ambivalent (Forgasz, 2004), and girls develop mental adaptation to technology.

Even in relevant studies, it was found that female students' have a more positive attitude towards technology than male students do (e.g. King, Bond & Blandford, 2002; North & Noyes, 2002; Whitley, 1997; Christensen et al., 2005). For instance, Jackson et al. (2013) found that girls in the experimental group performed over the other students within the learning environment where interactive table tops were used in mathematics lessons. There might be several reasons why girls have higher attitudes towards technology use in mathematics lessons than boys do. To begin with, Ursini, Sanchez, Orendai and Butto (2004) emphasized that boys in elementary schools deal with computers rather than learn mathematical topics, while girls try to complete the given mathematical tasks. Similarly, in a study by Vale and Leder (2004), it was found that girls were more likely to demonstrate a tendency to computers, which was associated with success in mathematics. Compared to views of boys about computers in mathematics, attitudes or views of girls were affected prominently by positive or negative effects of computers in learning and understanding mathematics, and girls emphasized more cognitive and useful aspects of technology in mathematics (Ursini and Sanchez, 2008; Christensen et al,2005). However, concerning technology, boys were likely to express views that were related to pleasure or enjoyment. In the same way, in the current study it could be said that girls might take advantage of technology more in mathematical tasks. In other words, .the reason why female students' displaymore positive attitudes than males do is likely to be the more positive perception of female students' regarding benefits of technology in learning mathematics. Thus, in participating classrooms, girls might improve their understanding of concepts and mathematics achievement with the help of technology. As a result, they might hold positive attitude towards technology.

Apart from the stereotype views of female and male students regarding technology in lessons, another reason of the girls having a more positive attitude than boys' is the variations in the amount of students' experience with computers in learning mathematics (Selwyn, 1998). Kubiatko, Halakova, Nagyova and Nagy (2011) expressed that computer experience increases positivity in attitude towards computers. In the current study, 59 percent of girls pointed out that they used technology to learn mathematics at home, while the corresponding ratio for boys was 45 percent. Hence, it might be inferred that since girls have more experience than boys, they have more positive attitudes than boys do.

Overall, despite the vast number of studies related students' computer attitudes, findings related to differences between male and female students' attitudes have varied over time. Hence, results are inconclusive or in contradiction with each other. In other words, the relationship between gender and attitudes is not a clear-cut (Teo, 2008). The reasons behind variations in the results might be in connection to the age and socio economic status of the sample, the instrument used and the definition of affective factors in those studies (Vale and Leder, 2004). Therefore, the reasons of inconsistent results may be caused by the characteristics of the sample and the instrument differing from the other generic attitude technology and mathematics scale. Regarding the analyses of the items in those scales, it is observed that items are mostly related with the emotional response to using technology rather than its usefulness in courses as mathematics. As regards emotional response, males are more eager and willing to use technology than girls since they are interested in computers at early ages compared to girls. Hence, it is not surprising that male students are more likely to like and enjoy using technological tools than girls. Consequently, while interpreting the differences in attitudes of students in terms of gender, it is crucial to consider characteristics of the sample, the items in the instrument and the amount of experience with technology.

Another finding of the current study is that there is no significant difference between students' attitudes in terms of grade level. Unlike this result, Balta and Duran (2015) and Forgasz (2004) found that younger students (7^{th} graders) have more positive attitudes towards computer based mathematics than older high school students (8^{th}-10^{th} graders). In contrast, there are also studies which favour older students in terms of attitudes towards computers (e.g. Bozionelos, 2001; Forgasz, 2002). For instance, in a study by Ursini Sanchez (2008) students' negative attitude in grade 7 changed to a positive attitude in grade 8, and even though their attitudes in grade 9 were less positive than they were in 8 grade, they had a positive disposition to computers in mathematics. The inconsistencies between the findings of those studies and those of the current study may stem from other external variables, such as experience of graders, sample characters and fetures of the instrument. Most of the mentioned studies measure students' general attitudes toward technology scales rather than their attitudes toward technology use specifically in mathematics. In addition, features of the sample in those studies are slightly different than the features of the sample participating in the current study. Thus, inconsistent results regarding differences in graders might lie behind variations between in those studies with respect to instrument and sample characteristics and current study.

In accessible literature, there are very few studies which support no significant difference in attitudes of graders. For instance, in the study of Vale and Leder (2004), it was found that there was no significant difference between 8^{th} and 9^{th} grade students' views concerning whether using computers in mathematics was a good idea or not. Similarly, Hurley and Vosburg (1997) found no significant difference between 7^{th} and 8^{th} graders' computer attitudes. In these studies, the reason underlying no significant difference among graders may have been the small gap between the grades. One of the reasons behind the result yielding no difference across graders in the current study may be the similar amount of time spent on technology use within the classroom because computer use and attitude is strongly related with each other. Since in all grades similar technological tools are used in mathematics lessons, it might be possible to say that the amount of their experience is the same among graders. Moreover, another reason may be that participants share similar socioeconomic statuses across grades (Forgasz, 2002). The vast majority of the participants of the current study were students enrolled in private schools. Thus, their socioeconomic status might show similarity across grades. As a result, it may be owing to this reason that students had similar attitudes towards technology use in mathematics lessons across grade levels.

5.4. Implications for Mathematics Education

As Berberoğlu and Çalıkoğlu (1991) stated, the underlying reason of constructs not emerging is that computers were not often used by participants. It could be inferred that the integration of technology could rarely be applied in those classrooms, and students may not have been familiar with technology in mathematics lessons. Moreover, demographic information revealed that nearly half of the students claimed that they did not use computers at their homes to learn mathematics. In order to increase the use of technology at schools, allocated time should be increased to make students familiar with the structure of the software (Pokay & Tayeh, 1997; Heid, 1997). In addition, teachers might be leading students to use computers or other technological devices out of school times. Studies indicated that using technology at home have a potential to increase effective integration of technology in schools (Knezek& Christensen, 2002). Specifically, using technology at home was related with lower anxiety of students within classrooms (Gale and Harris, 1994). Therefore, having more experience with technology in mathematics may lead students to develop positive attitudes towards technology and they can utilize the advantage of technology in discovering and understanding mathematical topics.

Moreover, the results indicated that students' had lower scores on the items in the *behavioural* and *cognitive aspect of attitude* than the scores on the items in the *emotional* aspect of attitude. This may indicate that students do not adequately interact with computers within classrooms and their engagement in learning mathematics with technology is at a moderate level. For effective use of technology in classrooms, teachers should have knowledge of how to integrate technology into the classroom, its effects on students' understanding and attitudes and which technology is appropriate in which topics. Hence, there is a need to provide mathematics teachers with training to build knowledge about technology integration (Pierce and Ball, 2009). Considering this, in-service training programs and seminars would be beneficial to give teachers an insight into how to select and use appropriate software and other technologies. It is also suggested that teachers can be given the opportunity to participate in a community where teachers are able to design technology enriched teaching methods (Drijvers, 2013). Moreover, preservice teacher training programs should also include courses related with how to integrate technology into the elementary mathematic curriculum. Thus, prospective teachers can learn how to use educational software during their undergraduate period and they can in this way reflect their knowledge and skills regarding technology integration into their teaching profession.

Curriculum developers should pay attention to the integration of technology in elementary school mathematics curriculum, and topics should be designed based on technological tools. Therefore, teachers will be aware of the importance of technology in mathematics education and they will be able to improve their knowledge concerning how to integrate technology into mathematics topics and in which mathematics topic it is appropriate to use technology to make students discover the mathematical idea.

The general aim of the integration of technology into mathematics is to support learning equally for all students. Therefore, all students should have equal chance to benefit from technology in mathematical topics (Ursini& Sanchez, 2008). However, in the current study there is a gap between female and male students' attitudes towards technology. In order to minimise the difference, teachers should select appropriate software, implement appropriate teaching strategies and behaviours (Barkatsas et al., 2009) to present technology in a way that is attractive and interesting for both males and females (Bovee, Voogt and Meelissen, 2007). Hence, both female and male students might share similar interests in technology and they might appreciate the importance of technology in their mathematics education and future careers. Furthermore, they could arrange sufficient time for female and male students to use technology in classrooms and meet male and female needs related to technological tools used in mathematics classrooms. In addition, teachers need to encourage students to share their knowledge and skills related with technology with other students (Vale and Leder, 2004).

5.5. Recommendations for Further Research Studies

Although the scale was developed as a-four factorial structure, two factors emerged based on the results of the exploratory factor analysis. In order to distinguish aspects, more studies should be conducted to identify the factorial structure of the scale. Moreover, it is anticipated that cross cultural validation and factorial invariance studies could be conducted by using the scale. Furthermore, the items in the scale aimed to measure attitudes of students toward technology in mathematics rather than towards a specific domain of mathematics such as geometry or a specific technology such as Geogebra. Therefore, a new scale could be developed to measure students' attitudes towards specific technology in a distinct mathematics domain.

Findings of a study by Barkatsas, Kasimatis and Gialamas (2009) revealed that the distribution of attitudes towards the use of technology in mathematics lessons have high inter-quartile range and high variations in boys' and girls' scores. Hence, it is not possible to explain these variations in scores by means of gender differences (Barkatsas et al., 2009). In other words, gender is not the only variable to explain female and male students' attitudes towards technology in mathematics lessons. With reference to this, they stated that there is a complex correlation between students' mathematics achievement and attitudes to learning mathematics with computers. Further research is required in order to understand the factors which may have an influence on students' attitudes and explain those complex relationships in detail and to determine the relationship between attitudes and achievement in addition to other factors such as confidence in mathematics.

The cross-sectional survey was conducted as a research method in the current study in order to identify middle grade students' attitudes towards technology use in mathematics lessons. As further research, it is strongly recommended that longitudinal research methods be used to gain a more profound insight into students' reactions to technology usage in mathematics lessons throughout the years in middle schools. With these longitudinal studies, researchers could have a chance to explore how students' attitudes differ with respect to grade level.

Based on the inferential statistics results, it was found that female students have significantly higher attitude scores than male students, and no significant difference among graders was found. Further quantitative and qualitative research studies regarding this issue are strongly recommended in order to provide a deeper understanding of the reason behind the difference in terms of gender and lack of difference in terms of grade level. Moreover, it is recommended that further qualitative research studies be conducted to investigate relationships between students' cognitive schemes and knowledge regarding use of tools and attitudes towards technology in mathematics in order to reveal the deeper picture of students' actual behaviours and attitudes.

In the national context, the number of research studies that have investigated attitudes of middle grade students towards the combination of technology and mathematics is limited. However, it is assumed that the use of technology in mathematics will increase in Turkey. Regarding this issue, it is recommended that more studies be conducted with more students from different regions of Turkey to confirm the results of the current study.

REFERENCES

Abbit, J. T., & Klett, M. D. (2007). Identifying influences on attitudes and self – efficacy beliefs towards technology integration among pre-service educators. *Electronic Journal for the Integration of Technology in Education*, *6*, 28-42.

Adams, P. (2011). ICT and pedagogy: opportunities missed. *Education 13: International Journal ofPrimary, Elementary and Early Years Education, 39* (1), 21-33

Aiken, L. R. (2000). *Psychological Testing and Assessment (10th ed.).* Boston, MA: Allyn and Bacon

Ajzen, I. (1988). *Attitudes, personality, and behavior*. Chicago: Dorsey Press.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological bulletin*, *84*, 888-918.

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Akkoyunlu, B. (2002). Educational technology in Turkey: Past, present and future. *Educational Media International*, *39*(2), 165 – 173.

Albarracín, D., Johnson, B. T., & Zanna, M. P. (2005). *The Handbook of Attitudes*.Mahwah, NJ: Erlbaum.

Alessi, S.M. & Trollip, S.P. (2001). *Multimedia for Learning: Methods and Development.* Boston, MA; Allyn and Bacon.

Alghazo, I. M. (2006). Quality of Internet Use by Teachers in United Arab Emirates. *Education, 126*(4), 769-781.

Allport, G.W. (1935). *Handbook of Social Psychology*. Worcester, Mass: Clark University Press.

Almeqdadi, F. (2010). Causes of the UAE Seventh Graders' Weakness in Solving Linear Equations of One Variable and a Suggested Recovery Plan for Them. *International Journal of Multidisciplinary Thought*, *1*(1), 155 – 172.

Amolo, S., & Dees, E. (2007). *The influence of interactive whiteboards on fifth-grade student perceptions and learning experiences*. Retrieved January 27, 2011 from Valdosta State University, Department of Curriculum and Instructional Technology Website: http://teach.valdosta.edu/ are/Vol6no1/PDF%20Articles/AmoloSArticle_ ARE_format.pdf.

Arslan, A. (2006). Attitude scale relation to computer-assisted learning. *Yüzüncü Yıl University Journal of Education*, *3*(2), 24-33.

Artigue, M. (2002). Learning mathematics in a CAS environment: the genesis of a reflection about instrumentation and the dialectics between technical and conceptual work. *International Journal of Computers for Mathematical Learning*, *7*(3), 245-274

Asil, M., Teo, T., & Noyes, J. (2014). The Validation and mMeasurement Invariance of the Computer Attitude Measure for Young Students (CAMYS). *Journal of Educational Computing Research*, *51*(1), 49–69.

Association of Mathematics Teacher Educators. (2006). *Preparing Teachers to Use Technology to Enhance the Learning of Mathematics: A position of the Association of Mathematics Teacher Educators*. Retrieved from http://www.amte.net/Approved%20AMTE%20Technology%20Position%20Paper.pdf

Aşkar, P. (1986). The development of a likert type attitude scale toward mathematics. *Education and Science*, *62*, 31-36.

Aşkar, P., Köksal, M., & Yavuz, H. (1991). Students' perceptions of computerassisted instruction environment and their attitudes towards computer assisted learning. *Educational Research*, *34*(2), 133-139.

Aydin, E. (2005). The use of Computers in Mathematics Education: a paradigm shift from "computer assisted instruction" towards "student programming". The Turkish Online Journal of Educational Technology, *4*(2), 27-34.

Aydoğan, A. (2007). *The Effect of Dynamic Geometry Use Together with Open-ended Explorations in Sixth Grade Students' Performances in Polygons and Similarity and Congruency of Polygons.* Unpublished master's thesis, Middle East Technical University, Ankara, Turkey

Baki, A. (2000). Preparing Student Teachers to Use Computers in Mathematics Classrooms through a Long –Term Pre-Service Course in Turkey. *Journal of Information Technology for Teacher Education*, *9*(3), 343-462.

Baki, A. (2001). Evaluation of Mathematics Education in the Light of information technology, *National Education Science*, *149*, 26-31.

Balta, N. & Duran, M. (2015). Attitudes of Students and Seachers towards the Use of Interactive Whiteboards in Elementary and Secondary School Classrooms. *TOJET: The Turkish Online Journal of Educational Technology*, *14*(2), 15-23.

Barkatsas, A. N., Kasimatis K., & Gialamas, V. (2009). Learning secondary mathematics with technology: Exploring the complex interrelationship between students' attitudes, engagement, gender and achievement. *Computers & Education*, *52*, 562-570.

Bear, G. G., Richards, H. C., & Lancaster, P. (1987). Attitudes toward Computers: Validation of a Computer Attitudes Scale. *Journal of Educational Computing Research*, *3*, 207–218.

Berberoğlu, G., & Çalıkoğlu, G. (1991). Türkçe Bilgisayar Tutum Ölçeğinin Yapı Geçerliliği. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi*, *24*(2), 841-845.

Bingimlas, K. (2009). The Barriers to the Successful Integration of ICT in Teaching and Learning Environments: A review of the literature. *Eurasia Journal of Mathematics, science and technology education*, *5* (3).

Borwein, J. M., & Bailey, D.H. (2003). *Mathematics by Experiment: Plausible Reasoning in the 21st Century*. Natick, MA: AK Peters.

Bosco, A. (2004). ICT Resources in the Teaching of Mathematics: between Computer and School Technologies: A case-study. *The Curriculum Journal*, *15*(3), 265-280.

Boser, R. A., Palmer, J. D., & Daugherty, M. K. (1998). Students' Attitudes toward Technology in Selected Technology Education Programs. *Journal of Technology Education*, *10*(1), 4–26.

Bovée, C., Voogt, J., & Meelissen, M. (2007). Computer Attitudes of Primary and Secondary Students in South Africa. *Computers in Human Behavior*, *23*(4), 1762–1776.

Boyraz, Ş. (2008). *The Effects of Computer Based Instruction on Seventh Grade Students' Spatial Ability, Attitudes toward Geometry, Mathematics and Technology.* Unpublished Master dissertation. Middle East Technical University, Ankara, Turkey

Bozionelos, N. (2001). Computer Anxiety: Relationship with Computer Experience and Prevalence. *Computers in Human Behavior*, *17*, 213–224.

Bransford J. D., Brown A. L., Cocking R. R. (2000). *How People Learn: Brain, Mind, Experience, and School.* Committee on Developments in the Science of Learning. Washington, DC: National Academies Press.

Brown, D., & Warschauer, M. (2006). From the University to the Elementary Classroom: Students' Experience in Learning to Integrate Technology in Instruction. *Journal of Technology and Teacher Education*, *14*(3), 599-621.

Chen, L. (2004). Cooperative Project-based Learning and Students' Learning Styles on Web page Development, *Journal of Educational Technology System*, *32*(4), 365-377.

Chou, C., Yu, S., Chen, C., & Wu, H. C. (2009). Tool, toy, telephone, territory, or treasure of information: elementary school students' attitudes toward the Internet. *Computers & Education*, *53*(2), 308–316.

Christensen, R., Knezek, G., & Overall, T. (2005). Transition points for the gender gap in computer enjoyment. *Journal of Research on Technology in Education*, *38*(1), 23-37.

Christou, C., Mousoulides, N, Pittalis, M, & Pitta-Pantazi, D. (2003). *Problem solving and posing in a dynamic geometry environment*. Proceedings of the 6th International Conference on Technology in Mathematics Teaching, 125-132.

Clements, D. (1999). *First experiences in science, mathematics, and technology*. In American Association for the Advancement of Science

Comber, C. & Lawson, T. (2013). Sustaining technological innovation: The example of videoconferencing in English Schools. *Education and Information Technologies*, *18*(4), 641-659.

Çelik, V., Yeşilyurt, E. (2013). Attitudes to technology, perceived computer self-efficacy and computer anxiety as predictors of computer supported education, *Computers & Education*, *60*(1), 148-158.

Çokluk, O., Şekercioglu, G., & Büyüköztürk, S. (2010). *Sosyal Bilimler İçin Çok Değişkenli İstatistik: SPSS ve Lisrel Uygulamaları*, Ankara: Pegem A Yayincilik.

Davis, F. D. (1993). User Acceptance of Information Technology: System Characteristics, User Perceptions and Behavioral Impacts. *International Journal of Man-Machine Studies*, *38*, 475-487.

Deaney, R., Ruthuen, K., & Henessy, S. (2003). Pupils perspectives on the contribution of information and communication technology to teaching and learning in the secondary school. *Research Papers in Education*, *18*(2), 142-160.

Dede, C. (1990a). The evolution of distance learning: Technology-mediated interactive learning. *Journal of Research and Computing in Education*, *22*(3), 247-264.

Delen, E., Bulut, O. (2011). The relationship between students' exposure to technology and their achievement in science and math. *TOJET: The Turkish Online Journal of Educational Technology*, *10*(3), 311-317.

Dix, K. (1999). Enhanced mathematics learning: Does technology make a difference? In J. Truran & K. Truran (eds.), *Making the difference* (Proceedings of the 22nd annual conference of MERGA Inc., held at Adelaide, South Australia, 4-7 July, 1999, pp. 192-199). Adelaide: MERGA

Dumais, S. A. (2009). Cohort and gender differences in extracurricular participation: The relationship between activities, math achievement, and college expectations. *Sociological Spectrum*, *29*(1), 72-100.

Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool; instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics*, *75*(2), 213-234.

Drijvers, P. (2012). *From text to 'lived' resources: mathematics curriculum materials and teacher development* (pp. 265-281). New York/Berlin: Springer

Dunham, P. H. (1991). Teaching with graphing calculators: A survey of research on graphing technology. In L. Lum (Ed.), *Fourth International Conference on Technology in Collegiate Mathematics*, (pp. 89-101). Portland, OR: Addison-Wesley Publishing Company.

Eagly, A. H., & Chaiken, S. (2007). The Advantages of an Inclusive Definition of Attitude. *Social Cognition*, *25*(5), 582-602.

El-Gayar, O., Moran, M., and Hawks, M. (2011). Students' acceptance of table pcs and implications for educational institutions. *Journal of Educational Technology and Society*, *14*(2), 58-70.

Ellington, A. J. (2003). A meta-analysis of the effects of calculators on students'achievement and attitude levels in precollege mathematics classes. *Journal for Research in Mathematics Education*, *34*(5), 433-463.

Ellington, A. J. (2004*). Calculators in the Classroom – A Review of Recent Research Findings*, Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST) Spring Forum, Baton Rouge, LA.

Engeström, Y., Miettinen, R. & Raija-Leena, P. (1999). *Perspectives on activity theory*. New York: Cambridge University Press.

Fahlberg-Stojanovska, L., & Trifunov, Z. (2010). Constructing and exploring triangles with GeoGebra. Annals. *Computer Science Series (Anale. Seria Informatică*), *8*(2), 45-54.

Falcade, R., Laborde, C. & Mariotti, M. A. (2007). Approaching functions: Cabri tools as instruments of semiotic mediation. *Educational Studies in Mathematics*, *66*, 317–333

Fennema, E., & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization, and sociocultural factors. *American Educational Research Journal*, *14*, 51-71.

Fennema, E., & Sherman, J. A. (1978). Mathematics achievement and related factors: A further study. *Journal for Research in Mathematics Education*, *9*, 189-203.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fogarty, G., Cretchley, P., Harman, C., Ellerton, N., & Konki, N. (2001). Validation of a questionnaire to measure mathematics confidence, computer confidence, and attitudes towards the use of technology for learning mathematics. *Mathematics Education Research Journal*, *13*, 154-160.

Forgasz, H. J. (1995) Gender and the relationship between affective beliefs and perceptions of Grade 7 mathematics classroom learning environments, *Educational Studies in Mathematics* , *28*, 219 -239.

Forgasz, H. J. (2002). *Computers for learning mathematics: Gendered beliefs*. In A. D.Cockburn & E. Narda (Eds.), Proceedings of the 26th Conference of the InternationalGroup for the Psychology of Mathematics Education, Vol.2 (pp.2-369 – 2-375). Norwich, UK: University of East Anglia.

Forgasz, H. J. (2003). Equity and beliefs about the efficacy of computers for mathematics learning. In N. A. Pateman, B. J. Dougherty & J. Zilliox (Eds.), *Proceedings of the 2003 Joint Meeting of PME and PMENA*, *2*, 381–388.

Forgasz, H. J. (2004). Equity and computers for mathematics learning: access and attitudes. In M. J. Johnsen Hmines & A. B. Fuglestad (Eds.), *Proceedings of the 28th Conference of the international group for the Psychology of Mathematics Education [PME]* (pp. 2-399-2406). Bergen, Norway: Bergen University College.

Forgasz, H. (2010). Teachers' and pre-service teachers' gendered beliefs about students and computers, in Teachers of Mathematics: *Recruitment and Retention, Professional Development and Identity*, eds Glenda Anthony and Barbro Grevholm, Swedish Society for Research in Mathematics Education, Sweden, pp. 67-77.

Forgasz, H. J. and Leder, G. C. (1996) Mathematics classrooms, gender and affect. *Mathematics Education Research Journal , 8*, 153-173.

Galbraith, P. (2006). Students, mathematics, and technology: assessing the present – challenging the future, *International Journal of Mathematical Education in Science and Technology, 37*(3), 277-290.

Galbraith, P., Haines, C. (1998). Disentangling the nexus: Attitudes to mathematics and technology in a computer learning environment. *Educational Studies in Mathematics*, *36*, 275-290.

George, V. (2010). *Emerging Technologies in Distance Education*. Athabasca University Press, pp.3-22.

Goldenberg, E. P. (2000). *Thinking (and talking) about technology in math classrooms: K-12 mathematics curriculum center issues paper series*. Newton, MA: Education Development Center, Inc.

Gomez, E.A., Wu, D., & Passerini, K. (2010). Computer-supported team based learning: The impact of motivation, enjoyment and team contributions on learning outcomes. *Computers & Education*, *55*, 378-390.

Goos, M., Galbraith, P., Renshaw, P., & Geiger, V. (2003). Perspectives on technology mediated learning in secondary school mathematics classrooms.*The Journal of Mathematical Behavior*, *22*(1), 73-89.

Gress, C. L. Z., Fior, M., Hadwin, A. F., & Winne, P. H. (2010). Measurement and assessment in computer-supported collaborative learning. *Computers in Human Behavior, 26(*5), 806-814.

Gülbahar, Y. (2007). Technology planning: A roadmap to successful technology integration in schools. *Computers & Education*, *49*(4), 943-956.

Habre, S. (2009). Geometric conjectures in a dynamic geometry software environment. *Mathematics and Computer Education, 43*(2), 151.

Hall, I. & Higgins, S. (2005). Primary students' perceptions of interactive whiteboards. *Journal of Computer Assisted Learning, 21*(2), 102-117.

Hannafin, R., Burruss, J., & Little, C. (2001). Learning with dynamic geometry programs: Perspectives of teachers and learners. *The Journal of Educational Research, 94*(3), 132-144.

Hannafin, M.J., & Land, S.M. (1997). The foundations and assumptions of technology-enhanced studentcentered learning environments. *Instructional Science, 25*, 167-202.

Hannula, M. S. (2004). RF01: Affect in mathematics education – exploring theoretical frameworks. In. M. J. Høines and A. B. Fuglestad (Eds.), *Proceedings of the 28th conference of the international group for the psychology of mathematics education* (pp. 107-109). Bergen: Bergen University College.

Hart, L. E. (1989). Describing the affective domain: Saying what we mean. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective* (pp. 37-45). New York: Springer-Verlag.

Hartley, M. S., & D. F. Treagust. (2014). Learner perceptions of the introduction of computer-assisted learning in mathematics at a peri-urban school in south africa. *Learning Environments Research, 17*, 95-111.

Heinich, R., Molenda, M., Russell, J. D. & Smaldino, S. E. (2002). Instructional media and technologies for learning (7th ed.). Upper Saddle River, NJ: Prentice-Hall.

Hermans, R., Tondeur, J. van Braak, J., Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education, 51*, 1499-1509.

Hogarty, K. Y., Lang, T. R., & Kromkey, J. D. (2003). Another look at technology use in classrooms: The development and validation of an instrument to measure teachers' perceptions. *Educational and Psychological Measurement, 63*(1), 139-162.

Hollebrands, K. (2003). Eighth grade students' understandings of geometric transformations in the context of a dynamic software environment. *Research paper presented at the Twenty-Seventh Annual Meeting of the International Group for the Psychology of Mathematics Education*. Honolulu, HI.

Hollebrands, K. F. (2007). The role of a dynamic software program for geometry in the strategies high school mathematics students employ. [Case Study]. *Journal for Research in Mathematics Education*, *38*(2), 164-192.

Holmes, K. (2009). Planning to teach with digital tools: Introducing the interactive whiteboard to preservice secondary mathematics teachers. *Australasian Journal of Educational Technology*, *25*(3), 351–365.

Hopson, M. H., Simms, R. L., & Knezek, G. A. (2002). Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technoloy in Education*, *34*(2), 109-119

Horzum, M. B. & Çakır-Balta, Ö. (2008). Farklı Web Tabanlı Öğretim Ortamlarında Öğrencilerin Başarı, Motivasyon ve Bilgisayar Kaygı Düzeyleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi (H. U. Journal of Education)*, *34*, 140-154.

Hoyles. C, & Lagrange, J-B (eds) (2009), *Mathematics Education and Technology – Rethinking the Terrain*, Springer.

Hu, P. J., Clark, T. H. K., & Ma, W. W. (2003) Examining technology acceptance by school teachers: A longitudinal study. *Information & Management*, *41*(2), 227-241.

Huang, H. M. & Liaw, S. S. (2005). Exploring user's attitudes and intentions toward the web as a survey tool. *Computers in Human Behavior*, *21*(5), 729-743.

Hull, A. and Brovey, A. (2004). The Impact of the Use of Dynamic Geometry Software on Student Achievement and Attitudes towards Mathematics. *Action Research Exchange*. *3*(1).

International Society for Technology in Education (ISTE). (1998). *National educational technology standards for students-connecting curriculum and technology*. Eugene, OR: International Society for Technology in Education.

International Society for Technology in Education. (2007). *National educational technology standards for students.* Retrieved from http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/2007Standards/NETS_for_Students_2007.htm.

International Society for Technology in Education. (2008). *National educational technology standards for teachers*. Retrieved from http://www.iste.org/Content/NavigationMenu/NETS/ForTeachers/NETS_for_Teachers.htm

Isiksal, M. & Askar, P. (2005). The effect of spreadsheet and dynamic geometry software on the achievement and self-efficacy of 7th-grade students. *Educational Research*, *47*(3), 333-350.

Jackson, A., Brummel, B., Pollet, C., & Greer, D. (2013). An evaluation of interactive tabletops in elementary mathematics education. *Educational Technology Research & Development*, *61*(2), 311-332.

Jonassen, D. H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In D. H. Jonassen, (Ed.), *Handbook of research on educational communications and technology* (pp. 693-719). New York: Macmillan.

Jones, T. S. (2002). Mentoring African-American educational media & technology students. *Tech Trends*, *46*(2), 11-14.

Jones, T., & Clarke, V. A. (1994). A computer attitude scale for secondary students. *Computers and Education*, *22*, 315–318.

Joyce, M., & Kirakowski, J. (2013). Development of a general internet attitude scale. In Marcus, A. ed. *Design, User Experience, and Usability. Design Philosophy, Methods, and Tools*, pp. 250-260, Third International Conference, DUXU 2014, Held as Part of HCI International 2014, Heraklion, Crete.

Kay, R. H. (1993). An exploration of theoretical and practical foundations for accessing attitudes toward computers: the Computer Attitude Measure (CAM). *Computers in Human Behavior*, *9*, 371–386

Kay, R. H. (2008). *Exploring gender differences in computer-related behaviour: Past, present, and future.* In T .T. Kidd & I. Chen, Social Information Technology: Connecting Society and Cultural Issues 12-30.

Kay, R. H., & Knaack, L. (2008). A formative analysis of individual differences in the effectiveness of learning objects in secondary school. *Computers & Education*, *51*(3), 1304-1320.

Kelloway, K. E. (1998). *Using Lisrel for Structural Equation Modeling: A Researcher's Guide.* London: Sage.

Kliene, R. B. (2005). *Principles and Practice of Structural Equation Modeling.* (Second Edition). NY: Guilford Publications, Inc.

Keser, H. (1999). *Öğrencilerin Bilgisayara Yönelik Tutumları.' A.Ü.Eğitim Bilimleri Fakültesi Öğrencileri Üzerinde Bir Araştırma*. Eğitim Fakültesi IV.Ulusal Eğitim Bilimleri Kongresi Bildirileri 2- Eğitim Teknolojisi, Dil Eğitimi, Mesleki ve Teknik Eğitim. Anadolu Üniversitesi, Eskişehir, s. 80-99

Kılıcoglu, O. & Altun, A. (2002). Ortaögretim okullarindaki ögrencilerin bilgisayar destekli egitime yönelik tutumlari. *Eğitim Araştırmaları Dergisi*, *8*, 175-187.

Knezek, G., & Christensen, R. (2008). Effect of technology-based programs on first and second-grade reading achievement. *Computers in the Schools, 24*, 23-41

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

Kubiatko, M., Usak, M., & Pecusova, E. (2011). Elementary school pupils' knowledge and misconceptions about birds. *Eurasian Journal of Educational Research*, *43*, 163-181.

Kulm, G. (1994). *Mathematics assessment: What works in the classroom*. San Francisco, CA: Jossey Bass Inc.

Kutluca, T. & Zengin Y. (2011). Matematik öğretiminde geogebra kullanımı hakkında öğrenci görüşlerinin değerlendirilmesi. *Dicle Üniversitesi Ziya Gökalp Eğitim Fakültesi Dergisi*, *17*, 160–172.

Laborde, C., & Strasser, R. (2010) Place and use of new technologies in the teaching of mathematics: ICMI activities in the past 25 years. *ZDM Mathematics Education*, *42*, 121-133.

Lebens, M., Graff, M., G. & Mayer, P. (2011). The affective dimensions of mathematical difficulties in schoolchildren. *Educational Research International*, *20*, 1-13.

Leder, G. C., & Forgasz, H. J. (2000). Mathematics and gender: Beliefs they are a changin'. In J. Bana & A. Chapman (Eds.), *Mathematics Education Beyond, 2*, 370-376

Lee, K.J.B. (2010). Effective policies for supporting education and employment of women in science and technology. *Paper prepared for the UN Women Expert Group Meeting on Gender, Science and Technology*, Paris, 28 September –1 October 2010.

Lee, Y.-J. (2010). Empowering teachers to create educational software: A constructivist approach utilizing Etoys, pair programming and cognitive apprenticeship. *Computers & Education*, *56*(2), 527–538.

Leong, P., Ho, C. P., & Saromines-Ganne, B. (2002). An empirical investigation of student satisfaction with Web-based courses. *World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education*, *1*, 1792-1795

Lester, P. M. (1996). *Images that injure.* Westport, CT: Praeger.

Levy P. (2002). *Interactive whiteboards in learning and teaching in two Sheffield schools: A developmental study*. Retrieved September 6, 2014, from http://www.shef.ac.uk/eirg/projects/wboards

Levine, T., & Donitsa-Schmidt, S. (1998). Computer use, confidence, attitudes and knowledge: A causal analysis. *Computers in Human Behavior*, *14*, 125–146.

Li, Q., & Ma, X. (2010). A Meta-Analysis of the Effects of Computer Technology on School Students' Mathematics Learning (PDF). *Educational Psychology Review, 22*(3), 215-243.

Lim, D. H. (2002). Perceived differences between classroom and distance education: Seeking instructional strategies for learning application. *International Journal of Educational Technology*, 3 (1), 28-45

Loyd, B. H., & Gressard, C. (1984b). The effects of sex, age, and computer experience on computer attitudes. *AEDS Journal*, *18*(2), 67-77.

Loyd, B. H. & Loyd, E. L. (1985). The Reliability and Validity of an Instrument for the Assessment of Computer Attitudes. *Educational and Psychological Measurement*, *45*, 903-909.

MacGregor, M. & Stacey, K. (1997). Students' understanding of algebraic notation: 11-15. *Educational Studies in Mathematics*, *33*, 1-19.

Marjanovic, O. (1999). Learning and teaching in a synchronous collaborative environment. *Journal of Computer Assisted Learning*, *15*(2), 129–138.

McCallum, B., Hargreaves, E. & Gipps, C. (2000). Learning: the pupil's voice. *Cambridge Journal of Education*, *30*(2), 275-288.

McCulloch, A. W. (2011). Affect and graphing calculator use. *Journal of Mathematical Behavior*, *30*(2), 166-179.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York, NY: Macmillan.

Meelissen, M. R. (2005). *ICT: More for Mickey than for Minnie? The role of primary education in making information and communication technology more attractive for girls and boy.*, Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Middleton, J. A. (1999). Motivation for achievement in mathematics: Findings, generalisations, and criticisms of the research. *Journal for Research in Mathematics Education*, *30*(1), 65-88.

Minor, M., Losike-Sedimo, N., Reglin, G., & Royster, O. (2013). Teacher Technology Integration Professional Development Model (SMART Board), Pre-Algebra Achievement, and Smart Board Proficiency Scores. SAGE Open, *3*(2), 1-10.

MONE. (2004). *Talim ve Terbiye Kurulu Baskanlığı, İlkögretim Matematik Dersi (5-8. Sınıflar) Öğretim Programı.* (Board of Education, Elemenatry school mathematics curriculum (5-8th grades) Ankara: MEB Basımevi.

Moreno-Armella, L., & Hegedus, S., & Kaput, J. (2008). Static to dynamic mathematics: Historical and representational perspectives. Special issue of Educational Studies in Mathematics: *Democratizing Access to Mathematics through Technology— Issues of Design and Implementation*, *68*(2), 99–111.

Morgan, R. K. (2008). Exploring the pedagogical effectiveness of clickers. *InSight: A Journal of Scholarly Teaching*, *3*, 31-36.

Morris, S., Gullekson, N., Morse, B., & Popovich, P. (2009). Updating the attitudes towards computers scale using American undergraduate students. *Computers in Human Behavior*, *25*(2), 535–543.

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

National Council for Accreditation of Teacher Education (2002). *Technology and the new professional teacher*. Washington, DC: National Council for Accreditation of Teacher Education.

Nelson, L. J. & Cooper, J. (1997). Gender differences in children's reactions to success and failure with computers. *Computers in Human Behavior*, *13*(2), 247- 267.

Nguyen, D. M., Hsieh, Y. J., & Allen, G. D. (2006). The impact of web-based assessment andpractice on students' mathematics learning attitudes. [Electronic Version]. *The Journal of Computers in Mathematics and Science Teaching*, *24*(1), 5-25.

Nickell, G. S., & Pinto, J. N. (1986). The computer attitude scale. *Computers in Human Behavior*, *2*, 301–306.

Nwabueze, K. (2004). Computers in abstract algebra, *International Journal of Mathematics Education in Science & Technology*, *35*(1), 39–49.

OECD (2013). Education at a Glance 2013: OECD Indicators, *OECD Publishing*. Retrieved from http://dx.doi.org/10.1787/eag-2013-en.

Olkun, S.; Altun, A. & Smith, G. G. (2005). Computers and 2D geometric learning of Turkish fourth and fifth graders. *British Journal of Educational Technology*, *36*(2), 317-326.

Olson, M.A., & Fazio, R.H. (2009). *Implicit and explicit measures of attitudes: The perspective of the MODE model.* In R.E. Petty, R.H. Fazio, & P. Briñol (Eds.), Attitudes: Insights from the new implicit measures. New York: Psychology Press.

Ozel, S., Ebrar Yetkiner, Z., & Capraro, R.M. (2008). Technology in K-12 mathematics classrooms. *School Science & Mathematics, 108,* 80-85.

Pallant, J. (2007). *SPSS Survival manual: A step by step guide to data analysis using SPSS for windows (3rd ed.).* Berkshire, England: Open University Press.

Pemberton, M. R. (1996). *Engineering mathematics: Research, education and industry linkage (pp. 511-519).* Canberra: Instihlte of Engineers

Pierce, R. & Ball, L. (2009). Perceptions that May Affect Teachers' Intention to Use Technology in Secondary Mathematics Classes. *Educational Studies in Mathematics, 71*(3), 299-317.

Pierce, R., & Stacey, K. (2010). Mapping Pedagogical Opportunities *Provided by Mathematics Analysis Software. Technology, Knowledge and Learning*, *15*(1), 1-20.

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

Pilli, O. (2008). *The effects of computer-assisted instruction on the achievement, attitudes andretention of fourth grade mathematics course.* Unpublished doctoral dissertation. Middle East Technical University, Ankara, Turkey

Pilli, O., & Aksu, M. (2013). The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics students in North Cyprus. *Computers & Education*, *62,* 62-71.

Pitta-Pantazi, D., & Christou, C. (2009). Cognitive styles, dynamic geometry and measurement performance. *Educational Studies in Mathematics*, *70*(1), 5-26.

Ploger, D., Klinger, L. & Rooney, M. (1997). Spreadsheets, patterns, and algebraic thinking. *Teaching Children Mathematics*, *3*, 330-334.

Prinsen, F. R., Volman, M. L. L., Terwel, J., & van den Eeden, P. (2009). Effects on participation of an experimental CSCLprogramme to support elaboration: Do all students benefit? *Computers & Education*, *52*(1), 113-125.

Reed, H. C., Drijvers, P., & Kirschner, P. A. (2010). Effects of attitudes and behaviours on learning mathematics with computer tools. *Computers and Education*, *55*(1), 1–15.

Reznichenko, N. (2007). *Learning with a Graphing Calculator (GC): GC as a cognitive tool*. Paper presented at the Annual EERA Conference, Clearwater, FA.

Risser, H. S. (2011). What are we Afraid of? Arguments against Teaching Mathematics with Technology in the Professional Publications of Organisations for US Mathematicians. *International Journal for Technology in Mathematics Education*, *18*(2), 97-101.

Rochelle, J., Pea, R., Hoadly, C., Gordin, D., & Means, B. (2001). Changing how and what children learn in school with computer-based technologies. *The Future of Children*, *10*(2), 76–101.

Rudduck, J. & Flutter, J. (2000). Pupil participation and pupil perspective: 'carving a new order of experience'. Cambridge Journal of Education , *30*(1), 75-89

Russell, M., Bebell, D., O'Dwyer, L.M., & O'Connor, K.M. (2003) Examining teacher technology use: implications for pre-service and in-service teacher preparation. *Journal of Teacher Education*, *54*(4), 297-310.

Ruthven, K., Deaney, R., & Hennessy, S. (2009). Using graphing software to teach about algebraic forms: A study of technology-supported practice in secondary-school mathematics. *Educational Studies in Mathematics*, *71*(3), 279-297

Salinas, M. F. (2008). From Dewey to Gates: A model to integrate psychoeducational principles in the selection and use of instructional technology. *Computers & Education*, *50*(3), 652-660

Sam, H. K., Othman, A. E. A. & Nordin, Z. S. (2005). Computer self-efficacy, computer anxiety, and attitudes toward the Internet: A study among undergraduates in Unimas. *Educational Technology & Society*, *8*(4), 205-219. Retrieved from http://www.ifets.info/journals/8_4/19.pdf

Seels, B., & Richey, R. (1994). *Instructional technology: The definition and domains of the field*. Washington, DC: Association for Educational Communications and Technology.

Selwyn, N. (1997). Students attitudes toward computers: validation of a computer attitude scale for 16–19 education. *Computers and Education*, *28,* 35–41.

Shaffer, D. W., & Kaput, J. J. (1999). Mathematics and virtual culture: an evolutionary perspective on technology and mathematics. *Educational Studies in Mathematics*, *37*, 97-119.

Sharpe, M. (2004a). The place of the new information technologies in the life of today's adolescent. *Russian Education and Society, 46*(6), 10-38.

Shashaani, L. (1994). Socioeconomic status, parents' sex role stereotypes, and the gender gap in computing. *Journal of Research on Computing in Education*, *26*(4), 433-451.

Shattuck, D., Corbell, K., Osbourne, J., Knezek, G., Christensen, R., & Grable, L. (2011). Measuring teacher attitudes toward instructional technology: A confirmatory factor analysis of the TAC and TAT. Computers in the Schools, *28*, 291-315.

Shin, N., Sutherland, L.M., Norris, C. A. & Soloway, E. (2012). Effects of game technology on elementary student learning in mathematics. *British Journal of Educational Technology*, *43*(4), 540–560.

Sinclair, B. (2004). *Introduction: Integrating the Histories of Race and Technology. Technology and the African-American Experience: Needs and Opportunities for Study.* Cambridge: MIT Press

Smalley, N., Graff, M., & Sanders. M. (2001). A Revised Computer Attitude Scale for Secondary Students, *Educational and Child Psychology*, *18*(3), 47-57.

Smarkola, C. (2007). Technology acceptance predictors among student teachers and experienced classroom teachers. *Journal of Educational Computing Research*, *31*(1), 65-82.

Smith Risser, H. (2011). What are we afraid of? Arguments against teaching mathematics with technology in the professional publications of organizations for US mathematicians. IJTME, *18*(2), 97-101.

Stacey, K., Chick, H. & Kendal, M. (2004). *The Future of the Teaching and Learning of Algebra*. Dordrecht, the Netherlands: Kluwer Academic Publishers

Subrahmanyam, K., Greenfield, P., Kraut, R., & Gross, E. (2001). The impact of computer use on children's and adolescents' development. *Applied Developmental Psychology*, *22*, 7–30.

Sweet, R. & Meates, A. (2004). ICT and Low Achievers: What Does PISA Tell Us? In A. Karpati (Ed.), *Promoting Equity through ICT in Education: Project, Problems, Prospects*. Budapest, Hungary: OECD and Hungarian Ministry of Education.

Teo, T. (2006) Attitudes toward computers: A study of post-secondary students in Singapore. *Interactive Learning Environments*, *14*(1), 17-24.

Teo, T.(2008). Pre-service teachers' attitudes towards computer use: ASingapore survey. *Australasian Journal of Educational Technology*, *24(*4), 413-424.

Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*, *52*(1), 302-312.

Teo, T. (2010). A path analysis of pre-service teachers' attitudes to computer use: Applying and extending the Technology Acceptance Model in an educational context. *Interactive Learning Environments*, *18*(1), 65-79

Teo. T., Chai, S. C., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among preservice teachers. *Asia-Pacific Journal of Teacher Education*, *36*(2), 163-174.

Teo, T., & Noyes, J. (2008). Development and validation of a computer attitude measure for young students. *Computers in Human Behavior*, *24,* 2659-2667

Thurstone, L.L. (1931). Measurement of social attitudes. *Journal of Abnormal and Social Psychology*, *26*, 249-269.

Tsai, C.-C. (2001) The interpretation construction design model for teaching science and its applications to Internet-based instruction in Taiwan, *International Journal of Education Development*, *21*, 401–415.

Tsai, M.-J., & Tsai, C.-C. (2010). Junior high school students' Internet usage and self-efficacy: A re-examination of the gender gap. *Computers & Education*, *54*, 1182-1192.

Ubuz, B., Ustun, I., & Erbaş, A. K. (2009). Effect of dynamic geometry environment on immediate and retention level achievements of seventh grade students. *Eurasian Journal of Educational Research, 35,* 147-164.

Vale, C. M. (2005). Student views of computer-based mathematics in the middle years: Does gender make a difference? *Educational Studies in Mathematics*, 287-312.

Vale, C., & Leder, G. (2004). Student views of computer-based mathematics in the middle years: Does gender make a difference? *Educational Studies in Mathematics*. *56*, 287-312**.**

Van de Walle (1998). Elementary and middle school mathematics: Teaching developmentally, (3rd ed.). New York: Addison Wesley Longman, Inc.

Vekiri, I., & Chronaki, A. (2008). Gender issues in technology use: Perceived social support, computer self-efficacy and value beliefs, and computer use beyond school. Computer & Education, *51*(3), 1392-1404.

Voogt, G. Knezek, M. Cox, D. Knezek, A. ten Brummelhuis. (2013). Under which conditions does ICT have a positive effect on teaching and learning? A Call to Action. *Journal of Computer Assisted Learning*, *29*, 4–14.

Whitley, B. E., Jr. (1997). Gender differences in computer-related attitudes and behaviors: A metaanalysis. *Computers in Human Behavior*, *13,* 1-22.

Wiest, L. R. (2001). The role of computers in mathematics teaching and learning. *Computers in the Schools*, *17*(1), 41-55.

Wittwer, J., & Senkbeil, M.(2008). Students' computer use at home related to their mathematical performance at school? *Computer & Education*, *50*, 1588-1577.

Woodrow, J. E. (1992). The influence of programming training on the computer literacy and attitudes of preservice teachers. Journal of Research on Computing in Education, *25*(2), 200–218.

Yanpar Şahin, T. ve Yıldırım, S. (1999). *Öğretim Teknolojileri ve Materyal Geliştirme.* Ankara: Anı Yayıncılık

Yildirim, S. (2000). Effects of an educational computing course on preservice and inservice teachers: A discussion and analysis of attitudes and use. *Journal of Research on Computing in Education*. *34*(4), 479-495.

Yoder, M. (2014). Buyer's guide: Tablets. Learning & Leading With Technology, *41*(6).

Zbiek, R. M., Heid, M. K., Blume, G.W., and Dick, T. P. (2007). Research on technology in mathematics education, A perspective of constructs. F. K. Lester (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning* (pp. 1169-1207). Charlotte, NC: Information Age.

Zhang, J. (2010). Technology-supported learning innovation in cultural contexts. Educational Technology Research and Development, *58*(2), 229-243.

Zhao, Y. (2007). Education in the Flat World: Implications of Globalization on Education. *Edge Magazine (Phi Delta Kappa International), 2*(4). 1-19

APPENDIX A:PATTERN MATRIX OF TMLAS IN THE PILOT STUDY

Item	Factor Loading		Communality
	Factor 1	Factor 2	
20	**0.80**	-0.02	0.62
16	**0.79**	0.01	0.64
19	**0.79**	0.06	0.68
13	**0.76**	0.1	0.67
15	**0.74**	0.05	0.60
36	**0.73**	0.10	0.61
12	**0.72**	0.08	0.59
38	**0.70**	0.2	0.67
10	**0.69**	0.12	0.58
35	**0.69**	0.11	0.56
25	**0.67**	0.05	0.49
17	**0.65**	0.12	0.52
32	**0.63**	0.25	0.63
23	**0.59**	0.20	0.51
26	**0.59**	0.24	0.54
24	**0.58**	0.13	0.44
9	**0.49**	0.10	0.31
27	0.32	-0.13	0.07
40	0.03	**0.70**	0.50
39	0.12	**0.69**	0.48
34	0.14	**0.68**	0.59
14	0.18	**0.66**	0.59
30	-0.06	**0.63**	0.40
31	0.29	**0.59**	0.60
41	0.03	**0.58**	0.37
29	0.12	**0.58**	0.43
37	0.04	**0.56**	0.34
22	0.22	**0.56**	0.48
28	0.16	**0.55**	0.42
2	0.16	**0.54**	0.41
7	0.10	**0.53**	0.35
8	0.20	**0.53**	0.43
21	0.86	**0.50**	0.29
4	0.33	**0.49**	0.51
3	0.24	**0.47**	0.38

1	0.23	**0.43**	0.34
18	0.11	**0.42**	0.24
33	0.16	**0.42**	0.27
11	-0.12	**0.41**	0.13
5	-0.21	0.37	0.10
6	0.80	0.12	0.03

Note. Maximum Likelihood extraction method and Oblimin with Kaiser Normalization rotation method was applied for the exploratory factor analysis. Factor loadings which are greater than 0.4 are signed with bold.

APPENDIX B:VERSION OF TMLAS

Sevgili Öğrenciler;

Aşağıda yer alan sorularla matematik derslerinde teknoloji kullanımı hakkındaki düşünceleriniz öğrenilmek istenmektedir. Verilen yargı cümlelerini okuyarak kendi düşüncenizi en iyi yansıtan **yalnız** bir seçeneği işaretleyiniz.

1.Sınıfınız: ( )5 ( )6 ( )7 ( )8

2.Yaşınız :

3.Okulunuz:

4.Cinsiyetiniz : ( ) Kız ( ) Erkek

5.Derste kullanılan teknolojiler: ( ) Projeksiyon ( )Videoveya CD

( ) Hesap makinesi ( )Akıllı tahta

( )Morpa ( )Geogebra,Cabri

( )Bilgisayar

6. Yukarıda belirtilen teknolojiler dışında derste kullanılan teknolojiler hangileridir?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

7. Hangi matematiksel <u>konularda</u> bu teknolojileri kullanıyorsunuz? Örnek vererek açıklayınız.

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

8. Okul saatleri dışında matematik konularını öğrenmek için bilgisayar kullanır mısın?

Evet ( ) Hayır( )

	Kesinlikle katılmıyoru	Katılmıyor	Kararsızım	Katılıyoru m	Kesinlikle Katılıyoru
1. Matematik dersinde teknoloji kullanmada kendime güvenirim.	1	2	3	4	5
2. Matematik dersinde teknoloji kullanılması beni çok eğlendirir.	1	2	3	4	5
3. Matematik derslerinde teknoloji kullanılması görsellik ve işitsellik (resim ve animasyon kullanımı) sağladığı için öğrenmemi kalıcı yapar.	1	2	3	4	5
4. Matematik dersinde teknoloji kullanılmasını severim.	1	2	3	4	5
5. Matematik dersinde teknoloji kullanmaya başlayınca bırakmak zor gelir.	1	2	3	4	5
6. Matematik derslerinde teknoloji kullanılmasının gerekli olmadığını düşünürüm.	1	2	3	4	5
7. Matematik derslerinde teknoloji kullanılması matematik başarımı artırır.	1	2	3	4	5
8. Matematik dersinde teknoloji kullanılmasının ilgi çekici bulurum.	1	2	3	4	5
9. Matematik dersinde teknoloji kullanarak problem çözmek için uygun biri değilim.	1	2	3	4	5
10. Matematik dersinde teknoloji kullanılmasından moralimi bozar.	1	2	3	4	5
11. Matematik derslerinde teknoloji kullanılması arkadaşlarımla olan iletişimimi artırır.	1	2	3	4	5
12. Matematik dersinde teknoloji kullanılmasından endişelenirim.	1	2	3	4	5
13. Matematik dersinde teknoloji kullanılmasından huzursuz olurum.	1	2	3	4	5
14. Matematik derslerinde teknoloji kullanılması derse	1	2	3	4	5

karşı motivasyonumu artırır.					
15. Matematik derslerinde teknoloji kullanılmasından kaygılanırım.	1	2	3	4	5
16. Matematik dersinde teknoloji kullanılmasına sinirlenirim.	1	2	3	4	5
17. Matematik dersinde kullanılan teknolojiyi içimden parçalamak geçer.	1	2	3	4	5
18. Matematik derslerinde teknoloji kullanılması şekilleri (örn; kare, düzgün beşgen..)çizmemde yardımcı olur.	1	2	3	4	5
19. Matematik dersinde teknoloji kullanılmasından rahatsız olurum.	1	2	3	4	5
20.Matematik dersinde teknoloji kullanılmasına düşman olduğumu hissediyorum.	1	2	3	4	5
21.Matematik dersinde teknoloji kullanıldığında kendimi rahat hissederim.	1	2	3	4	5
22. Matematik dersinde teknoloji kullanabileceğimden eminim.	1	2	3	4	5
23. Matematik dersinde teknoloji kullanıldığında dersi dinlemek hiç içimden gelmez.	1	2	3	4	5
24. Matematik dersinde teknoloji kullanmanın benim için zor olduğunu düşünürüm.	1	2	3	4	5
25. Matematik dersinde teknoloji kullanmayı beceremem.	1	2	3	4	5
26. Matematik dersinde teknoloji kullanılmasından sıkılırım.	1	2	3	4	5
27. Matematik dersinde teknoloji kullanmayı öğrenebilecek kadar kendime güvenmiyorum.	1	2	3	4	5

28. Matematik derslerinde teknoloji kullanılması kavramları (örn; üçgende yükseklik, çıkarma işlemi) öğrenmemi sağlar.	1	2	3	4	5
29. Matematik dersinde teknoloji kullanılması derse olan ilgimi arttırır.	1	2	3	4	5
30. Matematik derslerinde teknoloji kullanılması uzun işlemleri doğru ve hızlı yapmamı sağlar.	1	2	3	4	5
31. Matematik dersinde teknoloji kullanılması hoşuma gider.	1	2	3	4	5
32. Matematik derslerinde teknoloji kullanılması boşa zaman kaybıdır.	1	2	3	4	5
33. Matematik derslerinde teknoloji kullanılması sıkıcı konuların ilginç hale gelmesini sağlar.	1	2	3	4	5
34. Matematik derslerinde teknoloji kullanılması problemleri çözmemde bana yardımcı olur. (bilgiyi organize ve analiz etmede kolaylık sağladığı için).	1	2	3	4	5
35. Matematik dersinde teknoloji kullanıldığında aklım karışır.	1	2	3	4	5
36. Matematik dersinde teknoloji kullanılmasından korkarım.	1	2	3	4	5
37. Matematik derslerinde teknoloji kullanılması soruların çözümlerinin doğruluğunu test etmemi sağlar.	1	2	3	4	5
38. Matematik derslerinde teknoloji kullanılması öğrenmemi zorlaştırır.	1	2	3	4	5
39. Matematik derslerinde teknoloji kullanılması teoremlerin, kuralların ve özelliklerin nereden geldiğini anlamama yardımcı olur.	1	2	3	4	5
40. Matematik derslerinde teknoloji kullanılması kendi hızıma göre ilerlememi sağlar.	1	2	3	4	5
41. Matematik dersinde teknoloji kullanıldığında zamanın hızlı geçtiğini hissederim.	1	2	3	4	5

APPENDIX C: HISTOGRAMS OF PARTICIPANTS FOR TMLAS

Figure C1: Histograms of male and female participants for TMLAS

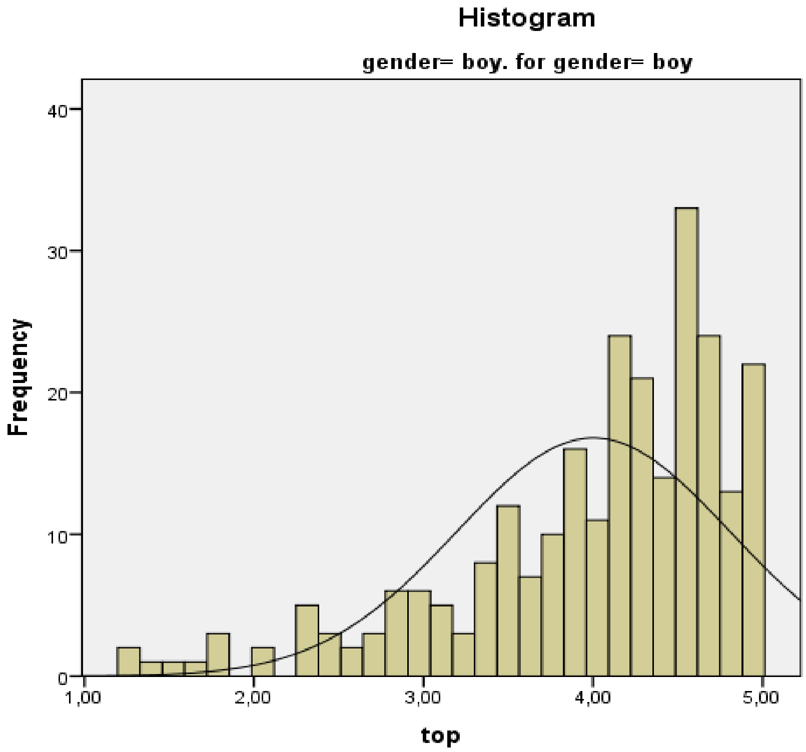
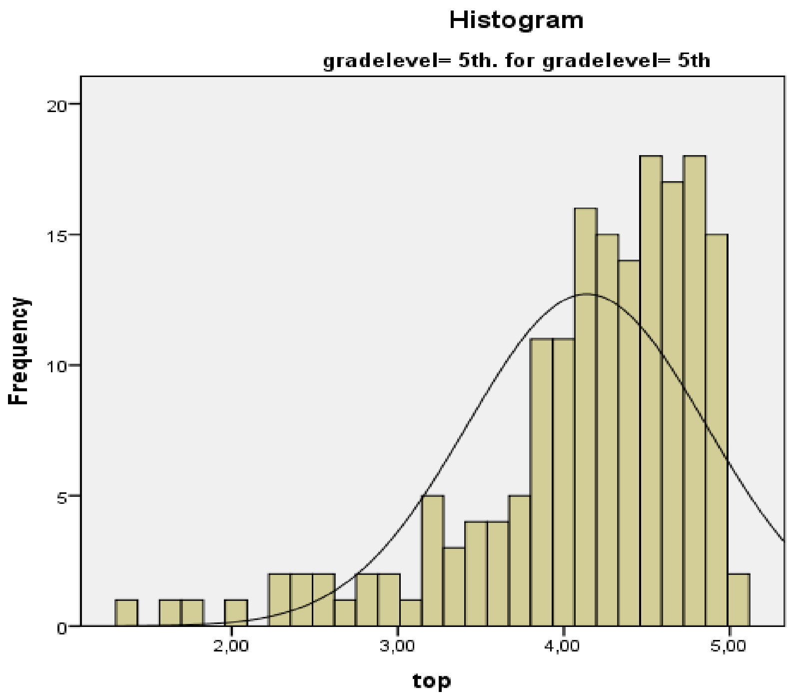
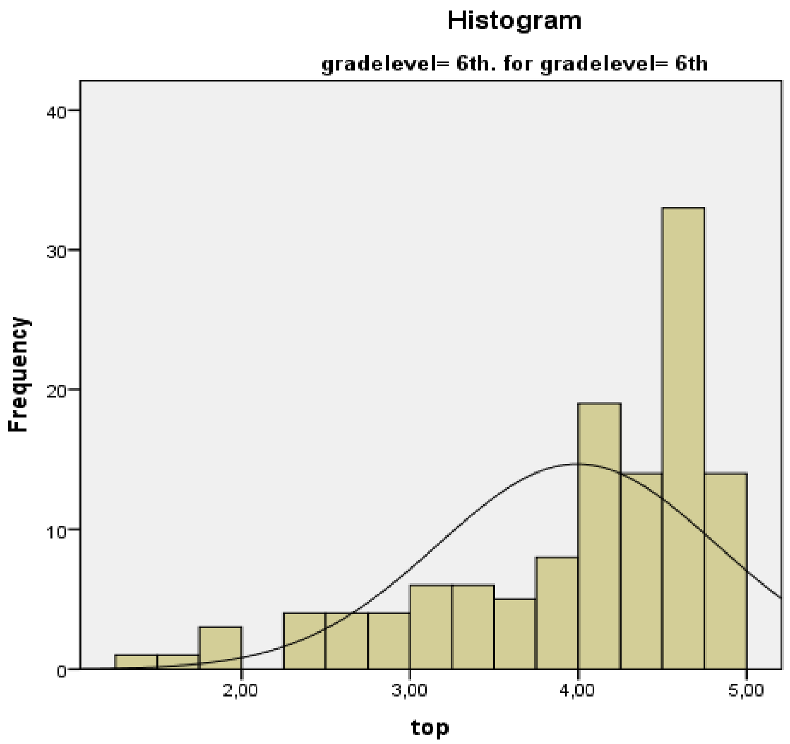
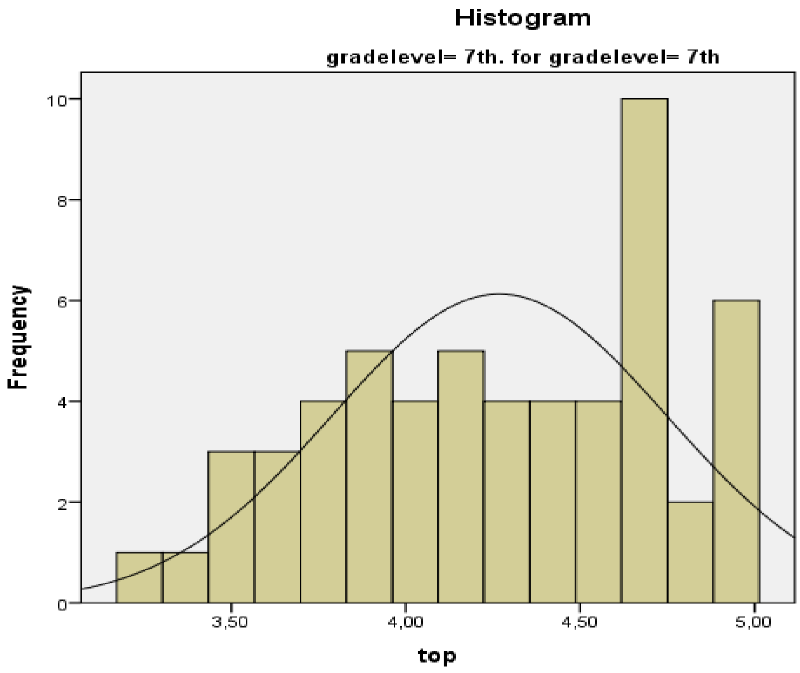
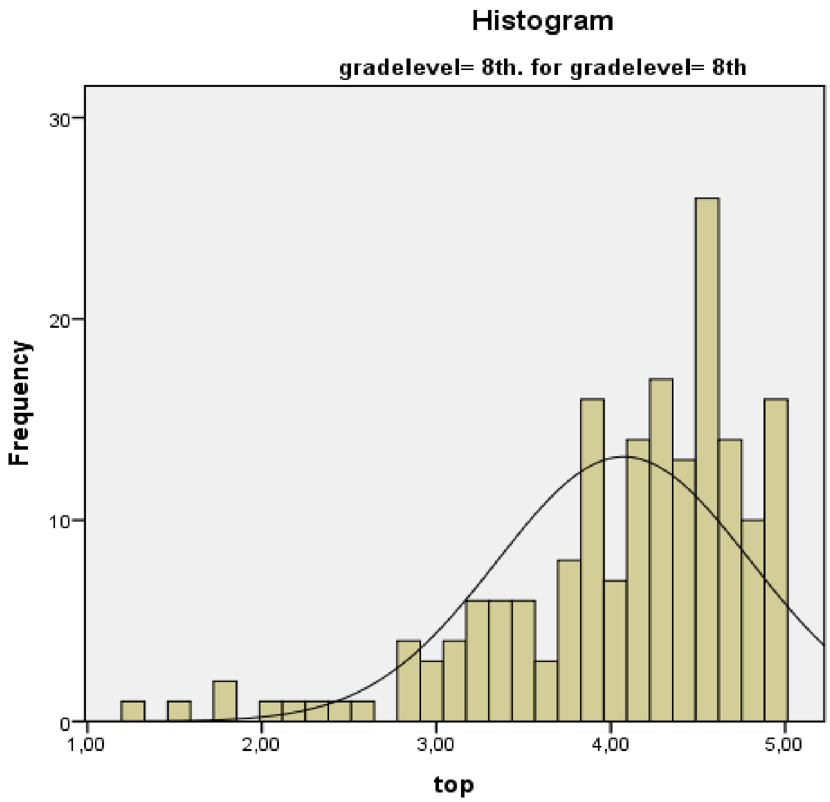


Figure C2: Histograms for 5th, 6th, 7th and 8th Grade Participants for TMLAS






Histogram
gradelevel= 7th. for gradelevel= 7th
Frequency
top
0
2
4
6
8
10
3,50
4,00
4,50
5,00


Histogram
gradelevel= 8th. for gradelevel= 8th
Frequency
top
0
10
20
30
1,00
2,00
3,00
4,00
5,00

APPENDIX D: ETİK İZİNLER

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20.03.2014

Gönderilen : Doç. Dr. Mine Işıksal
İlköğretim Fen ve Matematik Eğitimi Bölümü

Gönderen : Prof. Dr. Canan Özgen
IAK Başkanı

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz İlköğretim Fen ve Matematik Eğitimi Bölümü öğrencisi Emine Aytekin'in "Ortaokul Öğrencilerinin Matematik Dersinde Teknoloji Kullanımına Yönelik Tutumlarının İncelenmesi" isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

20/03/2014

Prof.Dr. Canan Özgen
Uygulamalı Etik Araştırma Merkezi
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b) 19/04/2014 tarihli ve 4616 sayılı yazınız.

Üniversiteniz Eğitim Fakültesi Yüksek Lisans Öğrencisi Emine AYTEKİN' in **"Ortaokul öğrencilerinin matematik derslerinde teknoloji kullanımına yönelik tutumlarının incelenmesi"** başlıklı tezi kapsamında çalışma yapma talebi Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Anket formunun (3 sayfa) araştırmacı tarafından uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde iki örneğinin (cd ortamında) Müdürlüğümüz Strateji Geliştirme Bölümüne gönderilmesini arz ederim.

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APPENDIX E: EXTENDED TURKISH SUMMARY

Ortaokul Öğrencilerinin Matematik Derslerinde Teknoloji Kullanımına Yönelik Tutumlarının İncelenmesi

GİRİŞ

Endüstri, tarım, sanat ve medya gibi birçok alanda teknoloji önemli bir yer tuttuğu için bireyler teknolojinin insan yaşamına getirdiklerini görmezden gelemezler. Teknolojinin insan yaşamını kolaylaştırdığı ve birçok yönden geliştirmeye devam ettiği de bir gerçektir. Teknolojideki yenilikler, toplumların eğitim sistemlerinde değişiklikler yapmasına ve kaliteli eğitim standartlarına ulaşmak için eğitim felsefelerini değiştirmesini desteklemekte ve kaçınılmaz hale getirmektedir. Ek olarak, 21. Yüzyıl için gerekli olan bilgi ve yetenekle öğrencileri donatmada teknoloji önemli bir rol oynamaktadır.

Çoğu araştırmacı teknolojinin eğitim sistemini geliştirmede ve desteklemede güce ve potansiyele sahip olduğunu belirtmektedirler (Jonassen & Reeves, 1996; Means, 1994). Buna bağlı olarak, Zhang (2010) öğrencilerin bilgi kapasitesini artırmak için teknoloji ile desteklenmiş yeni öğrenme teknikleri araştırmacılar tarafından geliştirildiğini belirtmiştir. Teknolojininin eğitimde kullanılmasını konu alan çalışmalar artmaktadır ve bu çalışmaların sonuçları teknolojinin öğrenme, öğretme, başarı ve motivasyonda büyük faydaları olduğunu göstermektedir (Asıl, Teo& Noyes, 2014).

Matematik eğitimine ilişkin, sosyo-kültürel öğrenme teorileri, öğrenci merkezli yaklaşım, işbirlikçi çalışmalar ve epistemolojik değerler ile şekillenen öğrenme ortamına olanak sağlayan sosyal ve iletişimsel aktivitelerden oluşmaktadır (Galbraith, 2006). Böyle bir ortamda, öğrenciler öğretmenlerin bilgisine ve cevaplarına tamamiyle bağlı kalmadan işbirlikçi çalışmalar ve öğrenciler arası tartışmalar ile tahmin ve çıkarım yapabilirler.Teknolojideki gelişmeler, öğrencilerin iletişim kurmasına, matematiksel özellikleri keşfetmede ve kendş düşüncelerini ve argümanlarını savunmalarına olanak verir (Galbraith, 2006).

Araştırma Soruları

Bu çalışmanın dört çalışma sorusu aşağıda verilmiştir.

1. Matematik Dersinde Teknoloji kullanımına yönelik geliştirilen tutum ölçeği güvenilir ve geçerli midir?
2. Ortaokul öğrencilerin matematik dersinde teknoloji kullanımına yönelik tutumları nedir?
3. Erkek ortaokul öğrencileri ile kız öğrencilerin matematik dersinde teknoloji kullanımına yönelik tutumlarının ortalamaları arasında istatistiksel olarak anlamlı bir fark var mıdır?
4. Öğrencilerin sınıf seviyelerine göre matematik dersinde teknoloji kullanımına yönelik tutumlarının ortalamaları arasında istatistiksel olarak anlamlı bir fark var mıdır?

YÖNTEM

Çalışma Deseni

Cross sectional survey (kesitsel tarama çalışması), tek seferde örneklemin karakteristik özelliklerini belirlemek amacıyla verilerin anket vasıtasıyla toplanmasıyla oluşan araştırma desenidir (Fraenkel& Wallen, 2006). Bu çalışmada öğrencilerin tutumları belirlemek amacıyla anket kullanılmıştır. Bu sebepten dolayı tarama çalışması bu çalışmanın araştırma yöntemidir. Ayrıca cinsiyet ve sınıf düzeyi açısından öğrencilerin tutumları arasında bir farklılık olup olmadıkları diğer araştırma sorularıdır. İki veya daha fazla grubun özellikleri arasındaki farklılıkları belirlemek amacıyla nedensel- karşılaştırma (causal comparative research design) araştırma deseni kullanılır (Fraenkel& Wallen, 2006). Bu sebepten ötürü nedensel-karşılaştırma araştırma deseni de bir diğer mevcut çalışmanın desenidir.

Katılımcılar

Bu çalışmada örneklem, amaçlı örneklem yöntemi kullanarak belirlenmiştir. Ulaşılabilir populasyonı Çankaya'da matematik derslerinde teknoloji kullanan ortaokullar oluşturmaktadır. Yapılan görüşme sonucunda yedi özel okul ve iki devlet okulu çalışmaya katılacaklarını bildirmişlerdir. Bunun sonucunda iki özel okul ve bir devlet okulu pilot çalışma için, beş özel okul ve bir devlet okulu ana çalışma için seçilmiştir.

Veri Toplama Aracı ve Veri Analizi

Matematik Derslerinde Teknoloji Kullanımı Tutum Ölçeği data toplama aracı olarak kullanılmıştır. Loyd ve Gressard (1984)'ın geliştirdiği Bilgisayara İlişkin Tutum Ölçeği temel alınarak ölçeğin boyutlarına ve bazı maddelerine karar verilmiştir.Ölçeğin ilk bölümü öğrencilerin yaş,cinsiyet, hangi teknolojileri kullandıkları ve hangi konularda teknoloji kullanıldığı sorulmuştur. Ayrıca evde matematik öğrenmek için teknoloji kullanıp kullanmadıkları sorusu eklenmiştir. Ölçeğin ikinci kısmında beşli Likert tipinde 1 'tamamen katılmıyorum' 5 'tamamen katılıyorum' olacak şekilde 40 maddeden oluşmaktadır. Maddeler sevme, kaygı, kendine güven ve fayda alt boyutlarına uygun olarak yazılmıştır.

Alan yazında, geliştirilen teknolojiye, bilgisayara, İnternete, bilgisayar destekli eğitime ve matematik ve teknolojiye yönelik tutum ölçekleri madde ve boyut olarak incelenmiştir (Loyd & Gressard, 1984; Selwyn, 1997; Aydoğan, 2007; Aşkar, Yavuz & Köksal, 1991; Kneezek & Christensen, 1996; Pierce, Stacey & Barkatsas, 2007; Baser et al., 2012; Jones & Clarke, 1994; Tsai, Lin& Tsai, 2001). Fakat, bu çalışmadaki amaç daha özel olarak matematik ve teknoloojiye ilişkin tutum ölçeği geliştirmektir. Geliştirme sürecinde Davis, Bagozzi ve Warshaw (1989)'ın geliştirdiği "Teknoloji Kabul Modeli" örnek alınmıştır. Bu modele göre tutum duruma, harekete/davranışa veya objeye karşı pozitif veya negatif duruş olarak tanımlanmıştır. Son zamanlarda tutum çok boyutlu ve bilişsel, duyuşsal ve hareket (davranışsal) alt boyutlarından oluştuğu saptanmıştır (Aiken, 2000). Duyuşsal boyut; his ve duygular, davranışsal boyut; davranım hakkında niyet ve durum son olarak bilişsel boyut; inanış, düşünce ve bilgi yapıları olarak ifade edilmektedir. Bahsedilen model temel alınarak Kay (1992) bilgisayara yönelik tutumları ölçmek için duyuşsal, bilişsel, davranımsal ve algılanan davranımsal kontrol boyutlarını belirlemiştir. Bunlara ek olarak algılanan fayda (bireylerin bilgisayarın gelecekleri ve kariyerleri açısından faydalı bulma inanışları derecesi) tutuma yeni bir boyut olarak belirlenmiştir. Tutum üzerine geliştirilmiş bu teori çerçevesinde, bu yapılar, öğrencilerin bilgisayarlara karşı tutumlarını ölçmede ve geçerli ölçekler geliştirmede önemli olmaktadır (Selwyn, 1997). Bu yüzden, geliştirilen ölçeğin boyutları belirlenirken bu teorik yapılar dikkate alınmıştır.

Bu teoriye ek olarak geliştirilen ölçekler incelendiğinde en sık kullanılan ölçek Loyd ve Gressard (1984) tarafından geliştirilen bilgisayara ilişkin tutum ölçeği olmuştur. Bu ölçekte; eğlence, kendine güven, bilgisayar kullanımı ve kaygı alt boyut olarak belirlenmiştir. Bilgisayar kullanımı alt boyutu Kay'ın algılanan fayda yapısı ile ilişkili olduğu saptanmıştır. Bu alt boyutu oluşturan maddeler; öğrencilerin bilgisayar kullanımlarının ilerideki iş performanslarına ve yaşantılarına katkı sağlaması ile ilgilidir. Fakat bu çalışmada teknolojiye ilişkin fayda alt boyutu için maddeler öğrencilerin gelecek kariyerlerine etkisinden farklı olarak teknolojinin matematik derslerinde kullanımı sonucunda öğrencilerin başarısını ve matematiksel terimleri anlamada etkisi göz önünde bulundurularak yazılmıştır. Bu sebepten dolayı ilgili alt boyutun maddeleri bu çalışmada kullanılmamıştır. Knezek, Christensen ve Myashita (1998) tarafından geliştirilen bir diğer ölçekte eğlenme, önem, motivasyon ve ısrar ölçeğin alt boyutları olarak belirlenmiştir. Son zamanlarda, Pierce, Stacey ve Barkatsas (2007) tarafından geliştirilen matematik ve teknoloji tutum ölçeğinde boyutlar matematikte güven, teknolojide güven, teknoloji ile matematik öğrenmeye ilişkin tutum, duyuşsal ve davranışsal katılım olarak saptanmıştır. Çoğu maddeler ayrı olarak teknoloji ve matematikle ilgili olmasına rağmen teknoloji kullanımının matematik dersinde faydası ile ilgili maddelerin de olduğu görülmüştür. Bu sebepten dolayı ilgili ölçeğin bazı maddelerinden faydalanılmıştır. Bahsedilen ölçekler yüksek güvenirliğe ve tutumun çok boyutlu yapısına uygun olarak hazırlandığı görülmüştür. Eğlence (enjoyment), sevme (liking) ve kaygı (anxiety) alt boyutundaki maddeler tutumun duyuşsal boyutu ile ilgili iken güven alt boyutundaki maddeler davranışsal boyutu oluşturmaktadır. Ek olarak, teknolojinin önemi veya faydası alt boyutu tutumun algılanan fayda yapısı ile örtüşmektedir.Teknolojinin önemi alt boyutundaki maddeleri yazabilmek için madde havuzu oluşturulmuştur. Son olarak maddeler kaygı, kendine güven, sevme ve fayda/önem alt boyutlarına uygun olarak hazırlanmıştır. Ölçme ve Değerlendirme alanındaki uzman görüşü sonucunda bazı maddeler silinmiş ve değiştirilmiştir.

SONUÇLAR VE TARTIŞMA

Geliştirilen Ölçeğin Geçerlik ve Güvenirliği

Ortaokul öğrencilerinin matematik derslerinde teknoloji kullanımlarına yönelik tutum ölçeği ulaşılabilir alan yazında bulunamadığından dolayı tutum ölçeği geliştirmek için Teknoloji Kabul Teori'si (Technology Acceptance Theory) temel olarak alınmıştır. Ölçeğin faktör yapısını belirlemek için açımlayıcı faktör analizi; belirlenen faktör yapısını test etmek için de doğrulayıcı faktör analizi kullanılır (Matsunaga, 2010; Pallant, 2007).

Verilerin uygunluğu KMO değerine ve küresellik Bartlett's testlerine bakılarak belirlenmiştir.Teknoloji kullanımına yönelik tutum ölçeği için KMO değeri 0.94 olarak hesaplanmıştır. Bu değer iyi olarak yorumlanabilir (Çokluk,Şekercioğlu & Büyüköztürk, 2010; Tabachnick& Fidell, 2007). Bartlett's küresellik testi (BTS değeri: 5981.6) faktör analiz için anlamlı bulunmuştur (Büyüköztürk, 2002). Veriler normal dağıldığında en iyi sonucu Maximum likelihood extraction yöntemi verdiği için bu yöntem kullanılmıştır (Costello & Osborne, 2005).

Açımlayıcı faktör analizi sonucunda, yamaç eğrisine (scree plot) göre ölçeğin iki faktörlü yapıya sahip olduğu görülmüştür. Döndürme olmadan (direct oblimin) açıklanan varyans oranı % 48'tir. Bu açıklanan varyans değeri belirlenen faktör yapısının güç derecesini göstermektedir ve sosyal bilimler için kabul edilebilir bir değerdir (Çokluk, Şekercioğlu& Büyüköztürk, 2010). Costello ve Osborne(2005)'e göre eğer communality değerleri 0.4'den büyük ise maddeler kabul edilebilirdir. Bu veri setinde madde 5, 6, 18, 21, 27 ve 33 dışında bütün maddelerin communality değerleri 0.4'ten büyüktür. Fakat madde 27 ve 33'ün değerleri 0.4'e yakın olmasına karşın madde 5 ve 6'nın communality değeri 0.4'ten az olduğu belirlenmiştir. Madde atmadan önce maddelerin faktör yüklerine bakılması önerilmektedir (Çokluk, Şekercioğlu& Büyüköztürk, 2010).

Stevens (2002) madde faktör yüklerinin en az 0.30 olması gerektiğini belirtirken Hair ve arkadaşları (2009) örnem büyüklüğünü temel alarak faktör yük değeri için öneride bulunmuşlardır. Bu bağlamda, bu çalışma için örneklem büyüklüğüne göre faktör yük değeri en az 0.4 olarak ele alınmıştır. Bu ölçekte, tabloda belirtilen madde 5 ve 6 dışında bütün maddelerin faktör yükleri 0.4'ten büyüktür ve çapraz yüklenen madde yoktur. Madde 18, 21,27 ve 33'ün faktör yükleri yüksek olmasına rağmen communality değerleri düşük olduğu için bu maddeler revize edilmiştir.

Tablo 1

Ölçekten Atılan Maddeler

Madde Numarası	Madde
5	Matematik dersinde teknolojiyi kullanmaya başlayınca bırakmak zor gelir.
6	Matematik derslerinde teknoloji kullanılmasının gerekli olmadığını düşünürüm.

Sonuç olarak, madde 1, 2, 3, 4, 5, 6, 11, 15, 18, 19, 25, 26, 27, 28, 30, 31, 34, 36, 37, 38 *teknolojiyi destekleme* boyutunda ve madde 7, 8, 9, 10, 12, 13, 14, 16, 17, 20, 21, 22, 24, 29, 32, 33, 35, *teknolojiyi benimsememe* boyutunda toplanmıştır.

Ölçeğin güvenirliği, ölçeği oluşturan maddeler arasındaki iç tutarlılık olarak tanımlanmıştır (George& Mallery, 2001). Cronbach Alpha değeri hesaplanarak ölçeğin güvenirlik katsayısı 0.94 ve 0.93 olarak bulunmuştur. Bu da maddeler arasında yüksek iç tutarlılığın olduğunu işaret etmektedir. George ve Mallery (2001)'e göre ölçeğin güvenilir olduğu sonucuna ulaşılabilir.

Belirlenen iki faktörlü yapının onaylanması için doğrulaycı faktör analizi yapılmıştır. Belirlenen modelin değerlendirilmesi için değişik uyum indeksleri gösterilmiştir (Kelloway, 1998). Bu uyum indekslerinden RMSEA değeri 0.069, normed chi square değeri 4, CFI ve NNFI değeri 0.97, NFI ve RFI değeri 0.96 bulunmuştur. Ayrıca GFI değeri 0.81; AGFI değeri 0.77 olarak hesaplanmıştır. Bu uyum indeksleri belirlenen standart değerlere göre iki faktörlü yapının modelle uyumlu olduklarını göstermektedir (Tabachnick& Fidell, 2007). Diğer bir deyişle, iki faktörde dağılan bütün maddeler, ilgili faktörle yüksek ilişkide olduğunu göstermektedir. Ancak, GFI ve AGFI değerleri beklenen değerden düşük çıkmıştır. Düşük değerin sebebi serbestlik derecesinin (degrees of freedom) örneklem sayısından fazla olması olabilir. Bu yüzden örneklem sayısını artırmak örneklem büyüklüğüne hassas olan GFI ve AGFI değerlerinin de artmasını sağlayacaktır (Sharma, Mukherjee, Kumar& Dillon, 2005).Tarihsel öneminden dolayı bu iki indeks değerleri çalışmalarda rapor edilmesine rağmen (Hooper et al., 2008), Sharma, Mukherjee, Kumar and Dillon (2005) son zamanlarda bu uyum indekslerinin önemini kaybettiğini ve modeli değerlendirirken bu indeksleri kullanılmaması gerektiğini savunmuşlardır. Bu sebeplerden dolayı, bu uyum indeksleri dikkate alınmamıştır. Diğer uyum indeksleri, açımlayıcı faktör analizi ile belirlenen modelin veri seti ile uyumlu olduğunu göstermiştir. Sonuç olarak; ölçeğin iki faktörlü olduğu belirlenmiştir.

Ölçeğin boyutları tutumun çok boyutlu tanımına uygun olarak belirlenmiştir. Tutumun boyutlarını duyuşsal, bilişsel ve davranımsal olarak üçe ayırmak mümkündür. Öçlekteki alt boyutlardan eğlence ve kaygı duyuşsal boyutu altında; kendine güven davranımsal boyut altında ve son olarak fayda/önem alt boyutu bilişsel boyutu altında yazılmıştır. Fakat açımlayıcı faktör analizi sonucunda iki faktörlü yapı ortaya çıkmıştır. Bu iki yapı incelendiğinde, boyutlar matematik derslerinde teknoloji kullanımına yönelik pozitif ve negatif eğilim şeklinde olduğu belirlenmiştir. Boyutların pozitif ve negatif diye ayrılması tutum yapısının basit tanıtımına uygunluk göstermektedir (McLeod, 1992). Ancak, önceden belirtildiği gibi maddeler tutumun çok boyutlu tanımına uygun olarak üç boyutta yazılmıştır. Uyumsuz bu sonuç tutumun teorik model tanımına bakmanın gerekliliğini ortaya koymuştur. Fishbein ve Ajzen (2010)'e göre tutum; teori ve ölçme olarak tek bir boyutta ele alınmaktadır. Diğer bir deyişle tutum tek boyuttur ve negatif veya pozitif olarak belirtilmektedir. Başka bir açıdan Eagly ve Chaiken (2007) tutumun bahsedilen üç yapıdan en az birinden oluştuğunu ifade etmişlerdir. Ek olarak, tutum çalışmalarında üç yapının ayrılmadığı durumlarının olabileceğini savunmuşlardır. Bu tanımdan yola çıkarak ortaya konulan iki faktör, tutum modelinin üç boyutunu içermektedir.

İki faktörlü yapının olmasının diğer bir sebebi ise; öğrencilerin matematik derslerinde teknoloji kullanımına ilişkin pozitif veya negatif algıya sahip olmaları olabilir. Böylece, öğrenciler tam olarak matematik derslerinde teknoloji kullanımını düşünmeksizin teknolojiye yönelik genel olarak pozitif veya negatif eğilim göstermiş olabilirler. Ortaokul öğrencileri o yaş aralığında teknolojiyi matematik derslerinde kullanılabilecek bir araç olarak düşünmemiş ve günlük yaşamlarında teknolojiyi kullandıkları gibi basit bir şekilde değerlendirmiş olabilirler. Diğer bir sebep ise matematik derslerinde teknoloji kullanım sıklığının yeterli seviyede olmaması olabilir. Böylece öğrencilerin tutumları üç ayrı yapıda ortaya çıkmamıştır. Benzer bir yargı Berberoğlu ve Çalıkoğlu (1991) tarafından yapılan çalışmada vurgulanmıştır. İlgili çalışmada bilgisayara ilişkin tutum ölçeği çok boyutlu çıkmamıştır. Bunun olası sebebi olarak katılımcılar tarafından yeterince bilgisayar kullanmama gösterilmiştir.

Orta Okul Öğrencilerinin Matematik Derslerinde Teknoloji Kullanımına Yönelik Tutumları

T-test analizi sonucunda ortaokul öğrencilerinin tutumlarının ortalaması 5 üzerinden 3.9 bulunmuştur. Bu yüzden öğrencilerin tutumlarının kısmen yüksek denilebilir. Bu sonuç Dündar ve Akçayır (2014) ve Boyraz (2008)'ın çalışmalarına benzerlik göstermektedir. Çoğu deneysel çalışmada, teknoloji kullanıldığında öğrencilerin bu teknolojiye karşı pozitif tutum sergiledikleri sonucuna varılmıştır (Ursini & Sanchez, 2008; Pierce, Stacey & Barkatsas, 2007; Aydoğan, 2007; Nguyen vd., 2006; Ursini, Sanchez& Orendai, 2004). Öğrencilerin pozitif tutum sergilemelerinin sebebi teknolojinin derslerde kullanılmasının öğrencilerin ilgisini çektiği gösterilebilir. Benzer şekilde Boyraz (2008) öğrencilerin bilgisayar ile uğraştıklarında dersten daha fazla keyif aldıklarını ve matematik derslerine karşı daha iyi tutum geliştirdiklerini dile getirmiştir çünkü geleneksel öğrenme ortamından farklı bir öğrenme ortamı öğrencilerin derse karşı ilgisini artırabilir bu da teknolojiye karşı pozitif bir tutum ile sonuçlanabilir.

Daha spesifik olarak öğrencilerin teknolojiye karşı olan tutumları diğer çalışmalar ile paraleldir. Örneğin öğrenciler "Matematik derslerinde teknoloji kullanmayı severim" isimli maddeye olumlu yaklaşmışlardır. Benzer şekilde eğlenme boyutunda yer alan "Matematik dersinde teknoloji kullanırken eğlenirim" Maddesine öğrenciler olumlu yaklaşmışlardır bu durum alan yazınla uyumluluk göstermektedir (Boyraz, 2008; Galbraith & Haines, 1998; Pierce vd., 2007; Pilli & Aksu, 2013). Ayrıca fayda/yarar boyutunda yer alan maddelere öğrenciler orta düzeyde katıldıklarını belirtmişlerdir. Teknoloji kullanımı geometrik şekilleri çizmeyi kolaylaştırır (ör; kare veya dikdörtgen), kavramları öğrenmeyi kolaylaştırır (ör; üçgen, öteleme, dönme), uzun işlemleri hızlı ve doğru yapmayı sağlar, matematik konuları ilginç hale gelir, problem çözmede yardımcı olur, problemlerin doğruluğunu test edilmesini sağlar, görsel ve işitsellik sağladığı için öğrenme kalıcı olur. Teknolojinin bu faydaları bir çok çalışma sonucunda desteklenmiştir (ör. Nguyen vd., 2006; Hartley & Treagust, 2014; Boyraz, 2008). Ayrıca öğrenciler teknolojinin başarılarını ve motivasyonlarını artırdığını belirtmişlerdir. Öğrencilerin yarar boyutundaki maddelere genel olarak katılmaktadır. Bu da onların teknolojinin önemini benimsediklerini göstermektedir. Teknoloji matematiksel ilişkileri keşfetme, açıklama ve tahmin etmede bir araçtır (Borwein & Bailey, 2003). Ek olarak, öğrenciler teknoloji ile donatılmış sınıflarda düşüncelerini tartışma ve paylaşma imkanı bulurlar. Bunun sonucunda teknoloji kullanımından zevk duyarlar ve pozitif tutum sergilemiş olabilirler.

Öğrencilerin pozitif tutumlarının diğer bir sebebi ise günlük yaşamlarındaki teknolojiye ilişkin tutumlarının pozitif olması olabilir. Buna ilişkin, Shook, Fazio ve Eiser (2007), öğrenciler araçla direkt bir deneyim yaşamadıkları zaman, kişisel teknoloji ile ilişkin görüşlerini derslerde teknoloji kullanımına genelleme eğilimi gösterdiklerini belirtmiştir. Bu yüzden öğrenciler teknoloji ile ilgili kişisel algılarını, matematik derslerinde teknoloji kullanımına ilişkin tutumlarına yansıtmış olabilirler. Sonuç olarak çıkan pozitif tutumu değerlendirirken bu durumu dikkate almak gereklidir. Öte yandan Rowe (1993) ilkokul öğrencilerinin bilgisayarları hem eğitimleri hem de gelecek yaşantıları için önemli bir araç olduğunu düşünmektedirler. Buna dayanarak, öğrencilerin pozitif tutumlarının diğer bir sebebi onların gelecek için teknolojiyi önemli görmeleri sayılabilir.

Cinsiyet ve Sınıf Düzeyi Farklılıkları

Bu çalışmada kız öğrenciler erkek öğrencilere kıyasla daha yüksek tutuma sahip oldukları görülmüştür. Bu çalışmanın aksine bir çok çalışma erkek öğrencilerin daha yüksek tutuma sahip oldukları sonucunu göstermiştir (Ursini & Sanchez, 2008; Dix, 1999; Vale & Leder, 2004; Jackson vd., 2013). Ek olarak Forgasz (2002) öğrencilerin teknolojiyi erkeklerin ilgi alanı olarak düşündüklerini belirtmiştir. Yine bu çalışmanın aksine bazı çalışmalar erkek ve kız tutumları arasında anlamlı bir fark olmadığını bulmuşlardır (Altun vd., 2004; Aşkar, Yavuz & Köksal, 1991; Dündar & Akçayır, 2014; Loyd & Gressard, 1987). Bahsedilen çalışmalar ile bu çalışmanın sonucu arasında tutarsızlığın sebebi çalışmalardaki örneklem farklılığından kaynaklanmış olabilir. İlgili çalışmaların örneklemini lise veya üniversite öğrencileri oluştururken bu çalışmada daha küçük yaşta olan öğrenciler örneklem olarak seçilmiştir ve ayrıca bu çalışmaların bir çoğu geçmiş tarihte yapılmıştır, bu da sonuçların farklılığına yol açmış olabilir. Bunlara ek olarak, geçmiş çalışmalarda genelde erkeklerin daha fazla bilgisayara sahip oldukları ve teknoloji ile daha fazla ilgilendikleri bulunmuştur (Ordidge, 1997). Bu yüzden onların tutumu kızlara göre daha yüksektir. Fakat günümüzde teknoloji günlük yaşam ve kariyer için temel hale gelmiştir ve bu yüzden kızlar ve erkek öğrencilerin teknolojiye ilişkin tutum ve tercihlerini etkilemiştir (Thompson, 2013). Bu yüzden erkek ve kızlar arasındaki bilgisayara olan aşinalık ve geçirilen zaman miktarı yönünden farklılığın kapandığı iddia edilir (Dündar & Akçayır, 2014). Diğer bir yönden ise çalışmalar erkek öğrencilerin daha fazla teknik donanıma sahip olduğunu göstermesine rağmen, bu farklılığın değişken olduğunu (Forgasz, 2004) ve kızların teknolojiye karşın zihinsel bir adaptasyon geçirdiği söylenebilir.

Bu çalışmanın sonucuna paralel bazı çalışmalar kızların teknolojiye karşın erkeklere göre daha yüksek tutuma sahip olduklarını göstermiştir (ör. Christensen vd., 2005; King, Bond & Blandford, 2002; North & Noyes, 2002; Whitley, 1997). Kızların erkelere göre daha yüksek tutuma sahip olmalarının birçok nedeni olabilir. Bunlardan ilki, erkeklerin matematik derslerinde teknoloji kullanımına ilişkin görüşlerine kıyasla kızların görüşleri belirgin bir şekilde bilgisayarın matematiği öğrenme ve anlamadaki etkisine göre şekillenmekte ve kızlar teknolojinin matematikte kullanımının bilişsel ve faydası üzerinde daha çok durmaktadırlar (Cristensen vd., 2005; Ursini & Sanchez, 2008). Fakat, erkekler daha çok bilgisayarın zevk verme ve eğlenme yönünden düşüncelerini belirtmektedirler. Bu yüzden teknolojinin matematikte faydası bakımından kız öğrenciler erkek öğrencilere göre daha yüksek tutum sergilemiş olabilirler. Bu yüzden katılımcı sınıflarda kızlar teknoloji sayesinde erkeklere göre matematikte daha başarılı olmuş olabilirler ve dersi daha iyi anlamışlardır diyebiliriz. Böylece bu durum tutumlarını yansımıştır.

Buna ek olarak kızlar ve erkeklerin matematik dersinde teknolojiyi kullanma sıklığındaki farklılıklar tutumları arasında farklılığa sebep olmuş olabilir (Selwyn, 1998). Kubiatko vd. (2011) teknolojiyi kullanma sıklığının artması öğrencilerin pozitif tutum geliştirmelerine sebep olduğunu belirtmişlerdir. Bu çalışmada kız öğrencilerin yüzde 59'u evde matematik dersi için teknolojiyi kullandıkları belirtirken erkek öğrencilerdeki bu oran yüzde 45'tir. Bu yüzden kız öğrencilerin erkek öğrencilere göre daha yüksek tutuma sahip oldukları söylenebilir.

Bu çalışmada diğer bir bulgu ise sınıf seviyelerine göre öğrencilerin tutumları arasında bir fark bulunmamıştır. Bazı çalışmalar sınıf seviyeleri arasında farklılık bulmuşlardır. Örneğin; Balta ve Duran (2015) ve Forgasz (2004) çalışmalarında, küçük yaş grubu öğrencilerin büyüklere göre daha yüksek tutuma sahip olduklarını göstermişlerdir. Bunların aksine Bozionelos (2001) ve Forgasz (2002) çalışmalarında sınıf seviyesi arttıkça tutumun arttığını belirtmişlerdir. Bahsedilen çalışmalar ile bu çalışmanın sonucu arasındaki tutarsızlığa, sınıf düzeylerinin teknolojiyi kullanma süresindeki, örneklemdeki ve kullanılan ölçme aracındaki farklılıklar sebep olmuş olabilir. Örneklem olarak çoğu çalışmada lise öğrencileri seçilmiş ve derslerde kullanım düzeyleri bu çalışmada farklılık göstermektedir. Ayrıca bu çalışmalar öğrencilerin teknolojiye ilişkin genel tutumunu daha çok duyuşsal açıdan incelerken bu çalışmada kullanılan ölçek öğrencilerin daha özelde matematik derslerinde teknoloji kullanımına yönelik tutumlarını ele almaktadır.

Bu sonucu destekleyen çok az sayıda çalışmalarda biri olan Vale ve Leder (2004) 'in çalışmasında; sekizinci ve dokuzuncu sınıftaki öğrencilerin matematik derslerinde teknoloji kullanımının iyi fikir olup olmadığı konusunda görüşlerinde anlamlı bir fark bulunmamıştır. Bnezer şekilde Hurley ve Vosburg (1997) yedinci ve sekizinci sınıf öğrencilerin bilgisayara ilişkin tutumları arasında bir fark bulamamıştır. Bu çalışmalarda fark bulunmamasının sebebi sınıf seviyeleri arasındaki farkın az olması gösterilebilir.

Bu çalışmada sınıf seviyeleri arasında fark bulunamamasının sebebinin ise matematik derslerinde teknoloji ile geçirilen zamanın birbirine benzer olması gösterilebilir. Çünkü bilgisayar kullanım sıklığı ile tutum arasında güçlü bir ilişki bulunmaktadır. Diğer bir sebep ise öğrencilerin sosyo-ekonomik seviyelerinin birbirine yakın olması gösterilebilir (Forgasz, 2002).

Öneriler

Ölçek dört faktörlü yapıda geliştirilmesine rağmen faktör analizleri sonucunda iki faktörlü yapıda karar kılınmıştır. Boyutları ayırabilmek için başka örneklem gruplarıyla ölçeğin faktör analizi çalışmaları yapılabilir. Ayrıca bu ölçek kullanılarak kültürler arası doğrulama ve faktör değişmezliği çalışmaları planlanabilir. Bu ölçek temel alınarak öğrencilerin spesifik matematik konularında spesifik bir teknolojiye karşın tutumlarını ölçme adına yeni bir ölçek geliştirilebilir.

Barkatsas, Kasimatis ve Gialamas (2009)’ın çalışmasının sonucunda cinsiyetin erkek ve kız öğrencilerin tutumlarındaki farklılıkları açıklamada yetersiz kaldığına ayrıca tutum ve başarı arasında karmaşık bir ilişki olduğuna varılmıştır. Bu yüzden öğrencilerin tutumlarına cinsiyet dışında hangi değişkenlerin etkilediğine ilişkin çalışmalara yer verilmesi önemli olmaktadır.

Kız öğrencilerin tutumları erkek öğrencilere göre daha yüksek bulunmuş ve sınıf seviyeleri arasında bir farklılık bulunmamıştır. Bu farklılığın sebebini daha derinden anlayabilmek adına ek nicel ve nitel araştırma çalışmalarına yer vermek önerilebilir. Buna ek olarak öğrencilerin bilişsel yapılanmalarını (schemes) ve araç kullanma bilgilerini ile tutumları arasındaki ilişkiyi belirlemek adına ek nitel araştırmalar yapılabilir. Böylece öğrecnilerin davranışları ile tutumları arasında daha derin bir ilişki saptanabilir.

Ulusal bağlamda, ortaokul öğrencilerin matematik derslerinde teknoloji kullanımına ilişkin tutumlarını araştıran çalışma sayısı oldukça azdır. Türkiye’de teknoloji kullanımının sınıf ortamında yaygınlaşacağı düşünüldüğünde, bu çalışmanın başka örneklem grubuyla tekranlanması önerilmektedir.

APPENDIX F: TEZ FOTOKOPİSİ İZİN FORMU

<u>ENSTİTÜ</u>

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☒

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

<u>YAZARIN</u>

Soyadı : AYTEKİN
Adı : EMİNE
Bölümü : İLKÖĞRETİM FEN VE MATEMATİK EĞİTİMİ

<u>TEZİN ADI</u> (İngilizce) : INVESTIGATION OF MIDDLE GRADE STUDENTS' ATTITUDES TOWARDS USE OF TECHNOLOGY IN MATHEMATICS LESSONS

<u>TEZİN TÜRÜ</u> : Yüksek Lisans ☒ Doktora ☐

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

<u>TEZİN KÜTÜPHANEYE TESLİM TARİHİ</u>