A CASE STUDY OF THE USE OF MANIPULATIVES IN UPPER ELEMENTARY MATHEMATICS CLASSES IN A PRIVATE SCHOOL: TEACHERS' AND STUDENTS' VIEWS

BANU TUNCAY YILDIZ

FEBRUARY 2012

A CASE STUDY OF THE USE OF MANIPULATIVES IN UPPER ELEMENTARY MATHEMATICS CLASSES IN A PRIVATE SCHOOL: TEACHERS' AND STUDENTS' VIEWS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

BANU TUNCAY YILDIZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

FEBRUARY 2012

Approval of the thesis:

A CASE STUDY OF THE USE OF MANIPULATIVES IN UPPER ELEMENTARY MATHEMATICS CLASSES IN A PRIVATE SCHOOL: TEACHERS' AND STUDENTS' VIEWS

submitted by **BANU TUNCAY YILDIZ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Secondary Science and Mathematics Education Department, Middle East Technical University** by,

Prof. Dr. Canan Özgen _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ömer Geban _____
Head of Department, **Secondary Science and Mathematics Education**

Prof. Dr. Safure Bulut _____
Supervisor, **Secondary Science and Mathematics Ed. Dept, METU**

Examining Committee Members:

Prof. Dr. Ahmet Arıkan _____
Secondary Science and Mathematics Education Dept.,GU

Prof. Dr. Safure Bulut _____
Secondary Science and Mathematics Education Dept, METU

Prof. Dr. Ömer Geban _____
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Oya Yerin Güneri _____
Educational Sciences Dept., METU

Assist. Prof. Dr. Çiğdem Haser _____
Elementary Education Dept., METU

Date:_____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Banu Tuncay Yıldız
Signature :

ABSTRACT

A CASE STUDY OF THE USE OF MANIPULATIVES IN UPPER ELEMENTARY MATHEMATICS CLASSES IN A PRIVATE SCHOOL: TEACHERS' AND STUDENTS' VIEWS

Yıldız Tuncay, Banu
Ph.D. Department of Secondary Science and Mathematics Education
Supervisor: Prof. Dr. Safure Bulut

February 2012, 185 pages

The purpose of this study was to investigate the views of upper elementary mathematics teachers and students about the use of manipulatives in teaching and learning mathematics.

This study is a qualitative case study. The participants of this study were four elementary mathematics teachers in a private school and their 6^{th}, 7^{th}, and 8^{th} grade students. The data were collected through one-to-one interviews, observations and analyzing documents consisting of annual plan, daily plan, notebooks of students, and the field note that the researcher kept throughout the study.

This study revealed that although all the teachers advocate the use of manipulatives in teaching mathematics, they use traditional teaching techniques in their classes. They mentioned different factors affecting their use of manipulatives in teaching mathematics such as not knowing how to use them, grade level, availability of materials, time constraints, students' reactions (seeing them as a toy or not being accustomed to them), school administration, classroom management, not finding materials appropriate for the subject being taught and classroom size. In fact, these are the factors that are seen on the surface level. This study indicated that even when teachers are provided with training about the use of manipulatives, supported by the school administration, and provided with manipulatives, the use of manipulatives is largely determined by their views / beliefs about the nature of mathematics, how students can learn mathematics, the effect of manipulatives and their knowledge in

using them. Students seemed to like learning by using manipulatives. When conditions were arranged for learning, they were willing to learn through manipulatives.

Keywords: Manipulatives, Elementary Mathematics Teachers, Elementary Students, Teachers' Views, Students' Views, Mathematics Curriculum

ÖZ

BİR ÖZEL OKULDA İLKÖĞRETİM İKİNCİ KADEME MATEMATİK DERSLERİNDE SOMUT MATERYAL KULLANIMI ÜZERİNE BİR DURUM ÇALIŞMASI: ÖĞRETMEN VE ÖĞRENCİ GÖRÜŞLERİ

Yıldız Tuncay, Banu
Doktora, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Prof. Dr. Safure Bulut

Şubat 2012, 185 sayfa

Bu çalışmanın amacı ilköğretim ikinci kademe matematik öğretmenlerinin ve öğrencilerinin matematik öğretirken ve öğrenirken somut materyal kullanılmasına dair görüşlerini araştırmaktır.

Bu çalışma nitel bir durum çalışmasıdır. Bu çalışmanın katılımcıları bir özel okulda çalışan dört ilköğretim matematik öğretmeni ve onların 6. 7. ve 8. sınıftaki öğrencileridir. Veriler bire bir yapılan mülakatlarla, gözlemlerle ve yıllık planın, günlük planın, öğrencilerin defterlerinin ve araştırmacının çalışma boyunca tuttuğu alan notlarının analiziyle toplanmıştır.

Bu çalışma bütün öğretmenlerin matematik öğretiminde somut materyal kullanımını desteklemelerine rağmen, derslerinde geleneksel öğretim tekniklerini kullandıklarını ortaya çıkarmıştır. Somut materyallerin nasıl kullanılacaklarını bilmemek, kaçıncı sınıfta kullanılacakları, materyallerin ellerinde bulunup bulunmaması, zaman kısıtlamaları, öğrencilerin tepkileri (onları oyuncak olarak görmeleri ya da alışkın olmamaları), okul idaresi, sınıf yönetimi, öğretilen konuya uygun materyal bulunmayışı ve sınıftaki öğrenci sayısını öğretmenler kendilerinin matematik öğretirken somut materyal kullanımını etkileyen faktörler olarak belirtmişlerdir. Aslında, bu faktörler yüzeysel seviyede göründüğü kadarıyla böyle. Bu araştırma gösterdi ki öğretmenler somut materyallerin kullanımıyla ilgili eğitim alsalar, okul idaresi tarafından desteklenseler ve materyal kendilerine sağlansa bile materyallerin kullanımı büyük oranda öğretmenlerin matematiğin doğası,

öğrencilerin matematiği nasıl öğrenebileceği ve somut materyallerin etkisine ait görüşleri/ inançları ile kullanma bilgileri tarafından belirleniyor. Öğrenciler somut materyal kullanımıyla öğrenmekten hoşlanıyor gibi görünüyorlardı. Koşullar öğrenme için ayarlandığında somut materyal kullanımıyla öğrenmeye isteklilerdi.

Anahtar kelimeler: Somut materyal, ilköğretim matematik öğretmeni, ilköğretim öğrencisi, öğretmen görüşü, öğrenci görüşü, matematik müfredatı

To My Family: Taner, Zeynep, Caner, Ayşe, and Mazlum

ACKNOWLEDGMENTS

I would like to thank my supervisor Prof. Dr. Safure Bulut for her valuable guidance and help throughout the study. Without her moral support, I would not have been able to finalize my doctorate study.

Thanks to my committee members for their valuable feedbacks. I wish to express my gratitude especially to Assoc. Prof. Dr. Oya Yerin Güneri and Assist Prof. Dr. Çiğdem Haser for their guidance, advice, criticism, and encouragement.

I am grateful to my mother who provided valuable support throughout my life and this study. Thank you for your encouragement, patience, prayers and putting up with me and my daughter and son.

I also would like to thank my husband Taner for his unshakable faith in me and his willingness to help me in writing the thesis, for his support and help. Thank you for looking after our daughter and son while I was studying and for all the things you have done for me.

I am also grateful to my friend Ayşe Esra İyidoğan and Feride Yazır for their help and support while translating the data into English and checking grammar. I also would like to thank Esra's parents and sister Bilginur, Hüseyin and Cihan İyidoğan for their understanding, encouragements, moral support and opening their house to me for studying.

The rest of my appreciation goes to my colleagues and friends who don't leave me alone in this study.

Thank you all very much indeed.

TABLE OF CONTENTS

APPENDIXES

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER I

INTRODUCTION

"Every child can learn mathematics" is the fundamental principle of the current mathematics curriculum in Turkey (Ministry of National Education, 2009). The vision of the current curriculum depends on the idea that mathematical concepts, due to their nature, are abstract and therefore should be taught in line with the developmental level of students by using concrete, finite and real life examples (MoNE 2009, p.7). In addition, training individuals who will be able to use the mathematics in their lives, who can solve problems, who share their solutions and ideas, who have self-confidence in mathematics, and who have a positive attitude toward mathematics is the vision of the latest developed mathematics curriculum, as it is stated in the guide book prepared for the mathematics teachers of 6^{th} to 8^{th} graders (MoNE 2009, p. 9). This program emphasizes the importance of teaching mathematical concepts, the connection between these concepts, the meanings underlying operations and developing mathematical problem solving skills. In the curriculum, the significance of providing an atmosphere for the students in which they can do research, discover, solve problems, and share as well as discuss their solutions and approaches is highlighted. In such a context, the discovery of the aesthetic and enjoyable aspects of mathematics gains importance, and so does the students' becoming aware of the fact that they are dealing with mathematics when doing activities.

Elementary mathematics curriculum guides for grades 1-8 urge teachers and students to use concrete materials in mathematics education in all elementary

classrooms. The current desire to use devices to teach mathematics is not new since mathematics educators have supported their use for 200 years (O'Shea, 1993). For example, to Wardsworth (1971), there is a strong significance of having manipulative materials and concrete experiences as part of students' regular mathematics experience in theories of Bruner and Piaget. In addition, learning theories developed by Dienes, Piaget, Skemp, and Brownell suggest that children whose mathematical learning is firmly grounded in manipulative experiences will be more likely to bridge the gap between the world in which they live and the abstract world of mathematics (Kennedy, 1986). Pestalozzi, who is known as the father of the use of concrete materials, advocated their use in nineteenth century and then they were included in the activity curricula of the 1930s in United States (Sowell, 1989). According to Argün, Arıkan, Bulut and Sriraman (2010), introduction of instructional materials to make mathematics concrete is not new in Turkey as in 1948 curriculum, students learned the surface of circular region, circle and its center by investigating coins, gramophone records, round trays, clocks and objects that look like cylinders and in 1968 curriculum, the comparison of 1 dm^3 and 100 cm^3 was taught by using a box having a volume of 1 dm^3 and there were sample activities in the manual of 1983 curricula such as teaching the numbers and operations through the use of sets, number lines and figures.

As concrete materials have a long history in the mathematics classroom (Szendrei, 1996), different terms have been employed to name these materials such as "concrete models" (Fennema, 1972; Shultz, 1991), "concrete materials" (Sowell, 1974; Szendrei, 1996; Thompson, 1992) and "manipulatives" (Herbert, 1985; Kamp, 1989; Keller, 1993; Kennedy, 1986; Lewis, 1985; Holligsworth, 1990; Spungin and Voolich, 1993). According to Hynes (1986, p.11) manipulative materials are "*concrete models that incorporate mathematical concepts, appeal to several senses and can be touched and moved around by students*". The manipulative materials are "*devices or tools that engage the senses of sight and touch by handling or using them"* (Moyer, 1997, p.15) and they are "*materials designed to represent explicitly and concretely mathematical ideas that are abstract"* (Moyer, 2001, p.176). To MoNE, they can be objects which can easily be found around students such as beans, boxes, ropes, balls or water. These materials can be produced by commercial firms.

Geoboards, algebra tiles, base-ten-blocks are all among the products of such companies. They can also be made by teachers, parents or students themselves.

In the last 30 years, more than 100 studies have been conducted to examine the effectiveness of the manipulatives to teach various mathematical concepts. There are many research studies about the use of manipulatives in mathematics instruction and many of these studies suggest that students' achievement, conceptual understanding, attitudes and motivation improves through the use of manipulative materials (Allen, 2007; Bayram, 2004; Brown, 2007; Driscoll, 1984; Garrity, 1998; Getgood, 2001; Goins, 2001; Herbert, 1985; Parham, 1983; Smith 2006; Sobol 1998; Sowell, 1989; Suydam, 1984; Suydam & Higgins, 1997; Yolcu & Kurtuluş, 2010). However, Barnett and Eastman (1978) used the term "equivocal" for evaluating the results of using manipulatives in mathematics instruction as there is a contradiction in terms of students' achievement and attitudes toward mathematics. For example, Rust (1999) identified that although students seemed to enjoy the manipulative and hands on learning more than the bookwork, students taught with textbooks got higher scores than students taught by manipulatives. Similar to Baroody (1989), to Heddens (1997), if manipulatives are improperly used, they don't guarantee a meaningful learning. This may even mislead the students to think that there are two worlds in mathematics: the manipulative and the symbolic one.

One should be aware of the fact that by just using materials, student cannot understand the meaning of mathematical ideas on their own. Teachers have a crucial role in the journey of students from concrete to abstract as students are unable to make a connection between the physical world and abstract world without the teacher's assistance (Heddens, 1986). Due to that crucial role, Clements and McMillen (1996) warn that manipulative materials are not sufficient to guarantee meaningful learning. To Szendrei (1996), teachers must see that "*educational materials cannot achieve in themselves the teaching of mathematics. Mathematics is a value added to the material*" (p. 427). Learning aids are aids; they are not the whole instructional program (Spros, 1964). According to Thompson (1994), seeing mathematical ideas in concrete materials can be challenging. The material may be concrete, but the idea that students are intended to see is not in the material. To him, the idea is in the way the teacher understands the material and understands his or her

actions with it. In addition, teachers should understand that manipulative materials are designed to assist students to develop mathematical understanding rather than to achieve specific mathematical ends (O' Shea, 1993).

Teachers are the ones who decide whether to use or not to use manipulatives in teaching mathematics in their classes. Therefore, it is important to understand their views on manipulatives, why they use or do not use manipulatives and how they use them. In literature, there are studies shedding light on this subject. In general teachers advocate the use of manipulatives since they are of the opinion that the use of manipulatives enhances students' learning, increases their achievement and also students enjoy using them.

Much has been written about the factors the teachers consider in deciding whether to use manipulatives or not (Gordon, 1996; Hatfield, 1994; Herbert 1985; O'Shea, 1993; Howard et al, 1997; Howard, Perry & Lindsay 1996; Moyer & Jones, 2004; Szendrei, 1996; Trueblood, 1988). To Herbert (1985), many teachers often claim that there is not enough time to use manipulatives that using manipulatives is same as playing games and also it is difficult to manage them with large number of students. Trueblood (1988) maintains that teachers resist using manipulatives in the classroom for two reasons: a lack of confidence in their own ability to use manipulatives correctly and the general belief that children will become considerably dependent on these materials and as a result will not master basic computational algorithms and related concepts. Hatfield (1994) stated that availability of materials, teacher competency, transfer of learning from concrete to abstract level, classroom control, time factors, students' playing with them are the factors that teachers take into consideration when deciding whether or not to use manipulatives in mathematics instruction. Similar to Hatfield, Gordon (1996) also stated that teachers who did not necessarily disagree with the use of manipulatives felt that they had reasons beyond their control for not using manipulatives such as their unavailability, not having enough training on how to use manipulatives, not having enough time in the curriculum to use manipulatives, and having had classrooms where manipulatives were destroyed. The others have personal and reasons within their control for not using manipulatives. These teachers believe that manipulatives add no value to instruction and that manipulatives cause the concepts to get lost. Moreover, they

think that it becomes more difficult for students to comprehend the subjects when manipulatives are used and they also cause students to become bored with the instruction and in turn lose interest in the subject. Moreover, for some teachers the decision to use or not to use manipulatives is based on the amount of control they believe they will be able to maintain in their classrooms. For others, the decision to use manipulatives is based on their perception of the usefulness of each individual manipulative (Moyer & Jones, 2004). In general, many teachers think that mathematics is abstract and therefore do not use manipulatives (O'Shea, 1993; Szendrei, 1996).

"*Mathematics is abstract. We would like to create abstract concepts in the pupils' mind. They will intermix concrete objects like blocks, sticks, and so on with the mathematical concepts*" is a common remark made by the teachers that hate manipulatives (Szendrei 1996, p. 429). In addition, manipulatives should no longer be necessary in the assessment of students in secondary mathematics since assessment in most secondary mathematics courses is done at the abstract level and manipulatives helped students go from the concrete level to the abstract level (Gordon, 1996). School mathematics policies and the prescribed syllabus appear to have little impact on most teachers' use of manipulatives in their mathematics lessons (Howard, Perry & Lindsay, 1996; Howard, Perry & Tracey, 1997).

In addition, much research has been done to identify the use of manipulative materials in elementary and secondary schools (Gilbert & Bush, 1988; Hatfield, 1994; Hinzman, 1997; Howard, Perry & Lindsay, 1996; Howard, Perry & Tracey, 1997; Jones, 2010; Krug, 1988; Moyer, 1998; Moyer, 2001; Scott, 1983; Scott, 1987; Suydam, 1984). Parallel to factors mentioned above, the use of manipulatives decreases as the grade level increases (Gilbert & Bush, 1988; Hatfield, 1994; Howard, Perry & Lindsay, 1996; Howard, Perry & Tracey, 1997; Krug, 1988; Scott 1983).

Thus, teacher practices in class are not solely influenced by curriculum. Teachers' knowledge of mathematics, mathematics' teaching and learning, and how students think and learn also affect this practice (Ball & Cohen, 1996; Ernest, 1989; Thompson, 1984). Kagan (1992) contends that teachers' beliefs about how to teach

mathematics are situated in three spheres: 1- in context (the learning environment and the learners in that environment), 2- in content (the concepts and mathematical tasks to be addressed); and 3- in person (the beliefs and theories held by teacher). According to Archer (1999), in general, primary teachers tended to see mathematics as tied to both students' everyday lives and other aspects of the curriculum and therefore they use outside school activities. In contrast, secondary teachers tend to see mathematics as self-contained and it is their role to guide students through its orderly, logical structure. In order to get teachers to make use of manipulative materials a part of their lessons, before all else teachers' perceptions about the use of manipulatives should be understood as Brosnan (1994) suggests. To him, if reform in learning mathematics is to be successful, attention must be given to existing practices of mathematics teachers. Any attempt to improve the quality of mathematics teaching must begin with an understanding of the conceptions held by teachers and how these are related to their instructional practice.

In order to implement the curriculum effectively, it is indispensable that teachers are not only aware of what the goals of the curriculum are, but at the same time cognizant of the underlying theoretical assumptions embedded in the curriculum (Zanzali, 2003). The result of the study of Manouchehri and Goodman (1998) reveal that what teachers know about mathematics content and innovative pedagogical practices and their personal theories about learning and teaching mathematics affect how they value and implement new programs.

To sum up, we can say that teachers' beliefs about how students learn mathematics might influence how and why they use manipulatives as they do (Moyer, 2001). And in literature, there are studies investigating the relation of teachers' beliefs and the use of manipulatives in teaching mathematics (ex: Archer, 1999; Howard, Perry & Tracey, 1997; Jones, 2010). Jones (2010) examined the views of 6 teachers (grade 9 to 12) by interviewing them to understand how and why they chose or did not choose to use them in teaching mathematics. Similar to Jones, Archer also conducted an interview to get information about teachers. Howard, Perry and Tracey used questionnaires for their study. However, the actual use of manipulatives in the elementary schools should be investigated through direct observation and interview. Therefore, with the help of this study, we will have a deep

insight into the elementary mathematics teachers' views of the use of manipulatives, whether they use them or not, how they use them and the reasons behind their decision to use them or not in their classes together with the views of students. It is important for the researcher to get the views of students as students' attitudes is a major barrier to the use of manipulatives at the upper grade level since they see mathematics as a body of technical algorithms and believe that there is always a rule to follow in mathematics (Hinzman, 1997) and students' images of the activities in which they are asked to engage can affect the way teachers use manipulatives (Thompson & Lambdin, 1994).

In Turkey, there are studies related to the effect of the use of manipulatives on students' understanding and achievement such as those conducted by Bayram (2004), Erdoğan (2007), Toptaş (2008), Yolcu and Kurtuluş (2010). There are also studies related to preservice teachers and manipulatives. For example, Yıldız (2004) examined the perception of preservice teachers regarding the use of manipulatives. Like Yıldız, Özdemir (2008) also explored prospective elementary teachers' knowledge and skills about manipulatives and described the difficulties they had using manipulatives. In addition, Bakkaloğlu (2007) investigated self efficacy beliefs of preservice teachers regarding the use of manipulatives. Yıldırım (2008) examined the views of 10 elementary school teachers (grade 1 to 5) regarding the use of materials and tools in education. But although this study gave information on the use of materials and tools in grade 1-5, it did not provide detailed information about the use of manipulatives in mathematics teaching. There is a limited number of researches about how and why elementary teachers use manipulatives in their classes besides the fact that they are the ones who to implement the curriculum advocating the use of manipulatives in all elementary classes. Thus, in this study the researcher aimed to investigate the views of elementary mathematics teachers of grades 6-8 about the use of manipulatives to understand the rationale behind the use and non-use of manipulatives and how they use them and how students respond to them. However, studies regarding the teachers' views about the new mathematics curriculum include information about teachers' views about manipulatives. For example, Keleş (2009) investigated the views of 22 elementary teachers about new mathematics school curriculum and identified that elementary teachers had difficulty

in implementing the new curriculum since they lacked the necessary materials, the experience in using concrete materials and related teaching techniques. In his study, elementary teachers claimed that training was necessary for the use of concrete materials. Although the new curriculum emphasizes the use of manipulatives and activities in teaching mathematics, the study of Babadoğan and Olkun (2006) revealed that many teachers did not know how to use concrete materials that new mathematics curriculum required and had not been provided with the proper training. According to Yenilmez and Çakmak (2007), lack of sufficient numbers of concrete materials and lack of knowledge on how to use them was major barriers for the use of materials in mathematics instruction. Besides these, elementary teachers claimed that activities were not applicable in crowded classes (Bulut, 2007; Yenilmez & Çakmak, 2007). With the help of this study, besides understanding the views of the students and teachers about the use of manipulatives, the researcher also identifies the real barriers for use of manipulatives in teaching mathematics as in this study the necessary training on how to use the manipulatives was provided, the classroom size was appropriate and manipulatives were provided with the teachers.

Although the current curriculum has been applied since 2005 and the use of instructional materials in teaching mathematics was recommended by the curricula of 1948 through 2004 (Argün et all, 2010), the study of Memnun and Akkaya (2010) revealed that new mathematics curriculum is not totally implemented in all mathematics classes as seventh grade students are dissatisfied with the teaching method, having to solve many questions and examples in the lessons, and they request more enjoyable lessons. Therefore, this study is important as it shows the actual use of manipulatives in grades 6-8 and how teachers' perspective of the use of manipulatives affects their use in elementary mathematics teaching and how students view learning by using manipulatives. Such information is especially valuable for MoNE and curriculum developers as it provides insight into teachers' perspective on the current curriculum and particularly about the use of manipulatives, which will help those in charge of applying the new curriculum and training of the teachers to eliminate the reasons for not using them and to find ways to increase the application level. This study was undertaken with the conviction that a study of the actual practices of elementary mathematics teachers would provide the curriculum

developers with insight that will help them formulate effective future curriculum innovations in terms of the use of manipulatives. Such information is also valuable for teacher educators as they will get insight into experienced teachers' viewpoints regarding the use of manipulatives, their use in class and difficulties that they face during the use of manipulatives in teaching mathematics so that they can improve teacher education. Learning about teachers' use of manipulatives in class and students' views about the use of manipulatives in learning mathematics may also be useful for other teachers.

1.1. The Purpose of the study

The purpose of this study is to:

1. What are the views of upper elementary mathematics teachers about the use of manipulatives in teaching mathematics?
    a. How are upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics related to their views about mathematics, teaching and learning mathematics, and mathematics curriculum?
2. How do upper elementary mathematics teachers use manipulatives in their classes?
3. What are the views of elementary students about the use of manipulatives in learning mathematics?

1.2. Definition of Terms

*Manipulative*s: "*concrete models that incorporate mathematical concepts, appeal to several senses and can be touched and moved around by students*" (Hynes, 1986, p. 11)

Upper Elementary mathematics teachers: mathematics teachers of grades 6-8

Students: students of grade level 6-8 in elementary schools.

Algebra Tiles: rectangular shaped, colored concrete models of variables and integers to which we can attach the language of polynomials

Base ten blocks: wooden or plastic materials that represent one, tens and hundreds. They can be used in arithmetic operations in integers and decimal numbers.

Geoboards: 5*5 square array of pegs or circular in shape, which provides a context for a variety of mathematical investigations about area, perimeter, fractions, geometric properties of shapes and coordinate graphing

Four-Pan Algebra Balance: a unique tool for helping students makes sense of algebraic concepts. By using them, students can show -1 is less than 0 and physically represent and solve equations.

Fraction Bars: colored transparent area models of fractions

CHAPTER II

REVIEW OF LITERATURE

In recent years the use of manipulative materials for teaching mathematics in the elementary grades has received considerable support from many education communities including MoNE, universities. Elementary mathematics curriculum guides for grades 1-8 requests urges and students to use concrete materials in mathematics education in all elementary classrooms (MoNE, 2009). While adapting the new curriculum into life teachers have crucial role as they are the ones who implement the curriculum in classroom environment and decide to use or not use manipulatives in teaching mathematics. The aim of the study is to provide further details about how and why elementary school second degree mathematics teachers use manipulatives in their lessons. To do this firstly which factors acts on teacher and shape teachers' practices in the class will be explained in a conceptual framework. Later review of literature relevant to research with regard to the use of manipulative in learning and teaching mathematics will be presented.

2.1. Conceptual Framework

To Sandt (2007) educational reform centers on reforming or changing teacher behavior and it is essential to identify the factor influencing teachers behavior but also the relationship between them. To do this he proposed a research framework on the teacher behavior by expanding Koehler and Grouws' proposed model (1992) in which teachers behavior is influenced by the teachers' knowledge (content to be taught, how learners learn/ understand that specific content and methods to teach that

specific content, curriculum knowledge), teachers' attitudes and beliefs about teaching mathematics.

Teachers' knowledge consists of teachers' knowledge of student learning, subject content knowledge, pedagogical knowledge and newly added curriculum knowledge. Beliefs about the learning of mathematics and beliefs about students as learners were added to the original factors of teachers' beliefs about mathematics and the teaching of mathematics. Teachers' attitude toward students was added to the factor of teacher attitude which consists of teachers' attitudes toward mathematics and the teaching of mathematics. Social context is also important.

Jones (2010) in the study of "*Secondary mathematics teachers' views of manipulatives and their use in the classroom"* adapted van der Sandt's (2007) framework as illustrated in Figure 2.1 to examine teachers' behavior from the perspective of teachers' knowledge and views. He examined the views and use of manipulatives by secondary school mathematics teachers (grade 9 to 12) to understand how and why they chose or not to choose them in their teaching by interviewing 6 teachers.

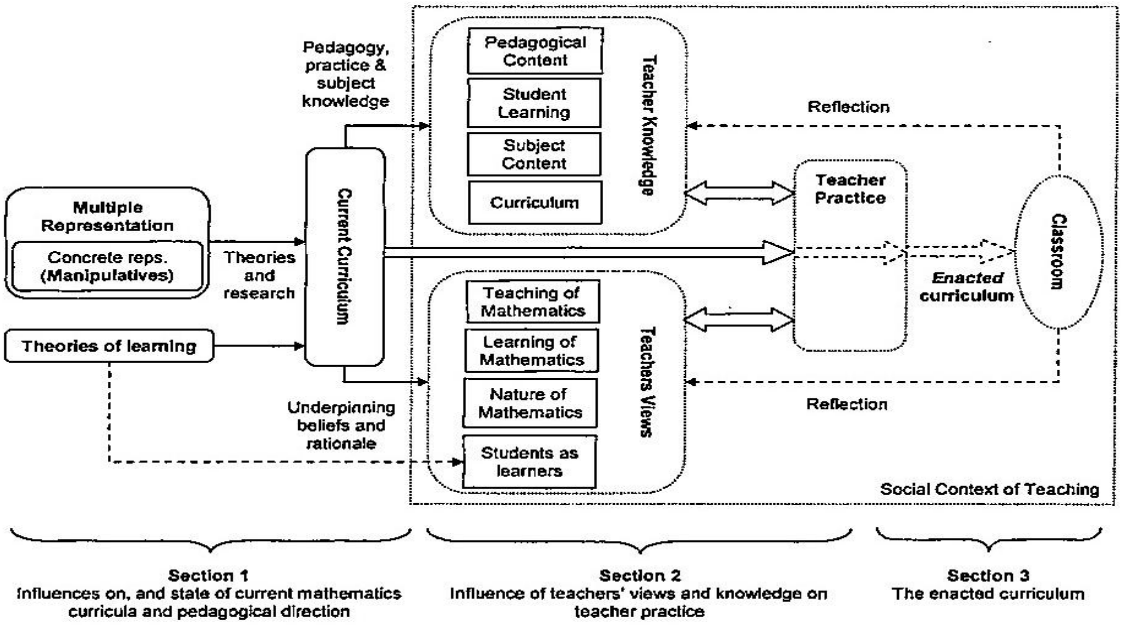


Figure 2.1. Conceptual Framework of Jones (p. 9)

The researcher of this study decided to use this conceptual framework to provide in which context teachers' views and use of manipulatives address the research question.

In Turkey, since 2004 last curricula have been developed and implemented in primary and secondary school with ongoing changes. Based on Figure 2.1, current curriculum has impact of teacher practices as well as teacher knowledge and belief. Therefore, it is important to give brief information what new mathematics curriculum brings to elementary mathematics education.

"*Every child can learn mathematics"* is the fundamental principle of the new mathematics curriculum. Mathematical concepts, due to its nature, are abstract and it is difficult for students to learn them directly. Therefore, mathematical concepts should be taught in line with the developmental level of students by using concrete, finite and real life examples. As a result, MoNE urges teachers and students to use concrete materials while learning/teaching mathematics. Training individuals who can be able to use the mathematics in their lives, who can be able to solve problems, who share their solutions and ideas, who has self-confident in mathematics and who has positive attitude toward mathematics are the vision of the newly developed mathematics curriculum stated in the guide book (MoNE, 2009). A conceptual approach, which aims to develop the mathematical concepts as well as developing mathematical expression problem solving skills, communication skills and other important abilities, has been incorporated in the curriculum. Learning environment where the students may research, discover, solve problems, and where they can share and debate their solutions and approaches is important in newly developed curriculum as students are responsible for their own learning and active in learning mathematics. This means that role of the teacher and students are different from the previous curriculum as teachers are not solely responsible for providing information rather they facilitate students' conceptual understanding. In addition, it is adopted the idea of associating mathematics within itself as well as other subjects and disciplines. The recently developed elementary school mathematics curriculums can be labeled as a reform based attempt to achieve the contemporary educational changes in the world (Umay et.al, 2006). However, according to the Argün, Arıkan, Bulut, and Sriraman (2010), related to daily life, connections in mathematics, problem solving,

various thinking skills, having positive attitude toward mathematics and esthetic feelings are the commonalities among the curricula of 1948 through 2004. Besides, to them, since throughout the all elementary school curricula, conceptual and procedural understandings were highlighted instructional approaches in all curricula were quite similar to each other. (Argün, et all, 2010)

In Turkey there are studies regarding the teachers' views about the new mathematics curriculum conducted mostly with elementary teachers (grade 1-5) and few with mathematics teachers (grade 6-8). According to Bulut (2007), elementary teachers were in the opinion that new mathematics curriculum based on student-centered approach and active students' participation. In addition, Kartallıoğlu (2005) identified that elementary teachers expressed that new curriculum enabled students explore and make reasoning. Although the new curriculum emphasize the use of manipulatives and activities in teaching mathematics, study of Babadoğan and Olkun (2006) revealed that many teachers do not know the use of concrete materials that new mathematics curriculum required and were not provided with proper training. According to Yenilmez and Çakmak (2007), lack of sufficient number of concrete materials and lack of knowledge on how to use them was major barrier for use of materials in mathematics instruction. Besides these, elementary teachers claimed that activities were not applicable in crowded classes (Bulut, 2007; Yenilmez & Çakmak, 2007). Keleş (2009) also identified that elementary teachers had difficulty in implementing the new curriculum since they have lack of materials and lack of experience with using concrete materials and related teaching technique. Moreover, elementary teachers claimed that training was necessary for the usage of concrete materials. In addition, mathematics teachers had the view that conducting the activities in new curriculum required more time than allowed (Keleş, 2009).

Zanzali (2003) carried out a study in order to understand how teachers interpret the demands of the curriculum, particularly those related to problem solving and concluded that "*the development and implementation of any curriculum will affect teachers in significant ways and if teachers are not helped in coping with demands brought by changes in the content, pedagogical and psychological considerations, the implementing process will not be effective. They argued that curricular changes that have occurred within the last couple of decades cannot be*

looked at superficially. It involves deep-rooted paradigmatic psychological and philosophical changes. (p 37)

Like Zanzali, Bay et al. (1999) stated that *making major curricular change is like bicycling in the mountains: you work hard to master one challenge, only to meet another. (p 503)*

As illustrated in Figure 2.1, teachers' views and knowledge effects teacher practice in the classroom. Therefore, how these views and beliefs affect teachers in literature will be discussed shortly.

Teacher practices in class do not solely influenced by curriculum, teachers' knowledge of mathematics, its teaching and learning and how students think and learn also effect this practice. (Ernest, 1989; Thompson, 1984). Like Ernest and Thompson, Manouchehri and Goodman (1998) revealed that what teachers knew about mathematics content and innovative pedagogical practices and their personal theories about learning and teaching mathematics affects how they valued and implement new programs. Therefore, according to Brosnan (1994), if reform in learning mathematics is to be successful, attention must be given to existing practices of mathematics teachers. He stated that any attempt to improve the quality of mathematics teaching must begin with an understanding of the conceptions held by teachers and how these are related to their instructional practice.

Successful implementation of the curriculum will heavily depend on the ability of teachers to transform the aspiration of the curriculum developers into form that can be accepted and understood by the students (Zanzali, 2003)

The study of Archer (1999) focused on links between beliefs and practices in the teaching of mathematics at both the primary and secondary levels. It was stated by Archer that:

> "*the reformist wanted teachers to focus on students'* conceptual understanding *of problems in everyday life that involved mathematics. Then teachers would encourage students to try to work out ways in which these real-life problems might solved. Teachers would not provide students with a set of how-to procedures. The point of mathematics was to help students make sense of everyday life. The reformers acknowledge, however that the changes*

they call for will not come easily. The notion of mathematics as a set of procedures to arrive at a right answer so deeply ingrained in most mathematics teachers and in teachers of mathematics teachers, that a re-focus on mathematics as a way of making sense of the world will be hard won (p. 2)

She found that most teachers in primary school saw mathematics as linked to everyday life and linked with other aspects of the school curriculum. Therefore, primary teachers argued that if mathematical concepts were demonstrated in physical way, students could better understood them. However, most of the secondary teachers seemed to view mathematics as more self-contained, a set of logical relationships that existed in abstract form almost divorced from the everyday lives of students. Archer concluded that although secondary teachers agreed that use of manipulatives in teaching mathematics help students understanding of mathematical concepts they did not use manipulation because they did not have time in an already full syllabus, they did not have secure rooms where they could keep equipment, and students tended to misbehave because they were out of routine.

Manouchehri and Goodman (1998) conducted as ethnographic research study over a 2 year period in order to investigate the implementation and evaluation of 4 standard based curricular materials by 66 middle school teachers at 12 schools in Missourri. They found that "*what teachers knew about mathematics content and innovative pedagogical practices and their personnel theories about learning and teaching mathematics were the greatest influences on how they valued and implemented the programs*" (p. 27). They detected a lag between many teachers' claimed pedagogical practices and their actual instructional methods and concluded that the more experience that the teachers had teaching with traditional approaches; the more they questioned the value and relevance of the programs. In addition, traditional teachers generally questioned both the value of the mathematics content discussed in the materials, and the adequacy of the suggested activities for the grade level they taught as they concerned covering the curriculum content requirements suggested in traditional text book. In this study, Manouchehri and Goodman also identified relation between use of materials and teaching experience of teachers and stated that teachers who had limited teaching experience and were unfamiliar with

instruction method that exceeded traditional methods and used materials either in addition to their more traditional lessons or with a particular group of children. Furthermore, teachers with limited experience and those with strong traditional orientation to teaching use particular program or unit as an enhancement activity which often lead to the production of a certain artifact for classroom decoration, without any discussion of its mathematical significance. Such superficial use of the materials did not affect the activities of the students, and in most cases, the students found them irrelevant to their mathematics learning. In addition, to them teachers who work environments emphasized active learning and constructivist philosophy used the materials consistently; and this occurred also for teachers who had little classroom experience. On the other hand, in schools where the teachers were surrounded by colleagues and peers who were skeptical about the standards-based curricula as well as about the practicality of the classroom practice materials, the teachers were less inclined to use the programs. In those situations the beginning teachers felt obliged to employ traditional practices, and even the teachers with constructivist perspective on teaching and learning reverted to a traditional routine of classroom instruction. Moreover, the teachers who worked within such environments had to use traditional textbooks and instruction methods because of school administration pressure for standardized tests and evaluation. This study also showed that time was important factor for all the teachers to successfully implement materials as the teachers spent more class time for familiarizing the students with the new skills in classrooms in which the students were unfamiliar with using manipulatives or engaging in collaborating learning activities. As a result, many teachers believed that changing classroom culture was impossible, considering the amount of time they had with students. Teachers participated in this study also anticipated “parents resistance to change” as a major obstacle in implementing innovative programs in their school districts.

To Ball (2000), teachers not only know the content but also can make use of it to help student to learn as there are some teachers that have important understanding of content but do not know how to teach to students. Therefore, pedagogical content knowledge is important for this interaction of knowledge and practice and it highlights the interplay of mathematics and pedagogy in teaching.

Mathematics is not an objective, feelingless subject. Teachers with negative attitudes toward mathematics employed methods that fostered dependency. To them, teachers became the main source of the information, students are passive learners and produce "one right answer", and use commercially prepared worksheets. In contrast, teacher with positive attitudes encourage students initiative and independence. Therefore, they use instructional materials and representation that provide students with resources other than teachers for self instruction (Karp, 1991).

Prior experience of prospective teachers give vivid images of mathematics as a fixed body of knowledge, best taught through memorization and drill (Ball, 1990).

2.2. Definition of Manipulative Material

When we look at the mathematics classes we can see that different types of tools have been used for improvement of students' achievement and positive attitude toward mathematics. And classification and definition of these tools were made in different ways by researchers.

Sowell (1974) differentiated materials in three kinds as concrete, pictorial and abstract. Concrete materials are those which can be move around or manipulated by children. Pictures, diagrams and charts are defined as pictorial materials. Abstract materials rely on numerals and words.

Like Sowell, Fennema (1972) also stated three types of models for mathematical ideas: concrete, symbolic and pictorial. A concrete model represents a mathematical idea through the three-dimensional objects. A symbolic model represents a mathematical idea of commonly accepted numerals and signs that show mathematical operation or relationships. The third type, the pictorial models, attributes both concrete and symbolic models.

Current desire to use devices to teach mathematics is not new since mathematics educators have supported their use for 200 years (O'Shea 1993). Pestalozzi, who known as father of the use of concrete materials, advocated their use in nineteenth century and then they were included in the activity curricula of the 1930s in United States (Sowell, 1989). Therefore, one can find lots of definitions of

"manipulatives" including the following acceptable ones. In addition, different terminology was used for manipulative materials such as "concrete models" (Fennema, 1972; Shultz, 1991), "concrete materials" (Sowell, 1974; Szendrei, 1996; Thompson, 1992) and "manipulatives" (Herbert, 1985; Holligsworth, 1990; Kamp, 1989; Keller, 1993; Kennedy, 1986; Lewis, 1985; Spungin and Voolich, 1993). In this study the researcher was used the term "manipulatives".

"*Manipulative materials are objects that can be touched, moved about, rearranged otherwise handled by children…They can be objects from the environment, such as money or measuring instruments or materials specifically designed to teach mathematical concepts, such as base-ten blocks and balances*." (Kennedy, 1986; p.6)

Hynes (1986) while focuses on a variety of criteria for selection of manipulative materials to find a response to the question of "what are the important characteristics of effective manipulative material" gave the definition of manipulative material. To him, *"manipulative materials are concrete models that incorporate mathematical concepts, appeal to several senses and can be touched and moved around by students."* (Hynes, 1986, p. 11)Manipulative materials are "*objects which represent mathematical ideas that can be abstracted through physical involvement with the objects*." (Young, 1988, p.40)

The Manipulative materials are "*devices or tools that engage the senses of sight and touch by handling or using them*" (Moyer, 1997, p.15) and they are "*materials designed to represent explicitly and concretely mathematical ideas that are abstract*". (Moyer, 2001, p.176)

According to Yeatts (1991) manipulatives are objects or things that appeal several of the senses and they are objects that students are able to feel, touch, handle and move.

Common household items like beans, buttons and blocks were used as early manipulatives but today there is a wide range of commercial manipulatives available from companies that specialize in instructional aids. Thus, manufacturers advertise manipulative materials that will make the teaching and learning of mathematics 'fun'

and promote their products as catalysts for engaging students in mathematical learning. (Moyer, 2001)

To sum up we can say that manipulative materials are objects requiring active involvement of students by handling, removing and used for mathematics instruction that vary in shape, size and color. They can be teacher or student- made or commercial. Pattern blocks, Cuisenaire- rods, geo-boards, base-ten blocks, fraction bars, symmetry mirror, dominoes, tangrams, algebra blocks, four-pan balance, pentominoes, snap cubes, calculators, cards, rulers, protractors, dices, graph paper, measuring cups, spinners, thermometers, rods or strips, geo-boards, tangrams and pentominoes are the examples of commercial manipulative. With the development of technology a new kind of manipulative that is "virtual manipulative" was introduced. Moreover, they are objects that have tactile and visual appeal and can be manipulated by learners through hands-on experiences (Moyer, 2001). By manipulating these materials students understand the meaning of mathematical ideas on their own. The researcher of this study used this information while preparing training for the participant teachers.

2.3. What is effective manipulative

Reys (1971) mentioned that manipulative materials must be used at the right time and in the right way if they are to be effective and "*failure to select appropriate manipulative materials and failure to use them properly can destroy their effectiveness*" (p 555).

The NCTM's Instructional Aids in Mathematics stated the characteristics of good manipulative material as "*be relevant to the mathematical content with a desirable outcome in min; exploit as many senses as possible, be durable, its durability being commensurate with its cost and anticipated usage; be durable, its durability being commensurate with its cost and anticipated usage; be constructed so that its details are accurate; have high standards of craftsmanship so that parts are not easily broken; be attractive in appearance; be maintained easily and at a reasonable cost; be adaptable to the school facilities (considering mobility and convenience of storage); be simple to assemble; be flexible and have a variety of*

assemble; be simple to operate; be large enough to be easily visible to all pupils, if used for demonstrations and either involve a moving part or parts or be something that is moved in the process of illustrating the mathematical principle involved (NCTM, 1973, p. 303).

The answer of "what are the important characteristics of effective manipulative materials" is the task of selection manipulatives. When selecting manipulative materials the teacher should consider the physical and pedagogical criteria. The pedagogical criteria refer to the educational potential of the material i.e. whether or not the materials serve the purpose for which they are intended and the physical criteria refer to the physical characteristics of the manipulatives. According to Reys (1971), being mathematically appropriate, clearly representing the mathematical concept, motivating, appropriateness for use in several grade levels as well as for different levels of concept formation, correctly embodying concept and providing opportunities for individual manipulation are the pedagogical selection criteria. To him, material should be durable, not divert attention of students away the concept being developed by have pleasing design, precision of construction and color to attract students' attention, appropriate in size for storage and children's physical competencies, simple to use and cost affordable taking into account initial expenditure, maintenance and replacement charges and he identified these properties as physical criteria in selection of materials.

Similar to Reys, Hynes (1986) also identified physical and pedagogical criteria for selecting manipulative materials. To him, durability, simplicity, attractiveness, manageability and ease of storage and reasonableness of cost are the physical criteria. According to him, careful plan should be done for distribution and collection of materials. Some are packaged for use by individuals or small groups, some can kept by students at their desk. If a manipulative has many small parts, they can easily be lost if adequate storage is not available. The pedagogical criteria include clear representation of mathematical ideas, appropriateness for students' developmental level, interest thus arising students interest and motivation, and versatility (material can be used to teach many mathematical concepts at various grade levels).

In the article entitled “considerations in the selection of learning aids” Spross (1964) stated that learning aids which are useful at several grade levels and adapted for the presentation of more than one mathematical concept are economically more desirable than highly specialized ones. In addition to its appropriateness for the particular concept to be taught, a device should be of durable material, esthetically attractive design and suitable size to accommodate children’s mental and physical competencies. Devices for teacher demonstrations should be large so that the teacher can perform the demonstration without obstructing the students’ view. This literature review showed that choosing right manipulative is the first step of starting to use manipulatives in teaching mathematics. Therefore, training about manipulatives includes knowledge of physical and pedagogical characteristics of materials.

2.4. How to teach use of manipulative materials

Many researches have been done regarding the use of manipulative materials in primary and secondary schools. One of the important factor that effect teachers to use manipulatives is teacher competency namely lack of knowledge of how to use manipulatives in mathematics instruction. (Gordon, 1996; Hatfield, 1994; Trueblooed, 1988)

Gordon (1996) analyzed the use of manipulatives in secondary school and identified that teachers did not necessarily disagree with the use of manipulatives felt that they have reasons beyond their control one of which is not have training on how to use manipulatives.

Teachers have a crucial role in the journey of students from concrete to abstract as students are unable to make a connection between the physical world and abstract world without teacher’s assistance. (Heddens, 1986)

Results of the meta-analysis of 60 studies from 1954 to 1987 indicate that long-term use of manipulative materials by experienced and knowledgeable teachers about use of materials increase mathematics achievement and students attitudes toward mathematics (Sowell, 1989).

In 1981, Scott applied a survey study to gain information on the current use of concrete materials in a large, urban school district. After the results of the survey of 1981, the school district has purchased kits of manipulatives and plan in-service trainings. The use of new kits and textbooks was implemented beginning in fall of 1982. In the spring of 1984 a survey somewhat similar to 1981 was applied. Compared to the results of 1981 survey, while no direct cause and effect relationship was tested, there is a dramatic increase in the use of materials in teaching of elementary school mathematics after the investment in mathematics materials kits and related in-service activities. Similar to this Krug (1988) also identified that teachers that have recent training on the use of manipulatives more probably use manipulative in their class. In this survey, the answer for format of in-service training was analyzed. Although 6.0% did not respond, 53.3 % of the respondents reported "many ideas for many grade levels", while 40.7% chose "one manipulative for one concept at your grade level", Moreover, there was as slight tendency for more intermediate teachers to prefer the "many ideas" format, and more primary teachers to prefer the "one concept" approach.

Johnson (1993) used various manipulatives with mathematics teachers and received comments that they understand what they did. For instance, when she briefly introduced algebra tiles by multiplying two binomials, one of the principal stated that "for the first time, I understand what I did to get the answer". According to her (1993), hands-on approach to teaching has rejuvenated many teachers because for the first time, many of them understand the mathematics they are trying to teach. Like Johnson, Trueblood (1988) also identified that amount of practice teachers have using with manipulatives also effect teachers attitudes. This influence also related to teachers perception of how manipulatives help them improve their understanding of mathematical concepts and relationships taught in the elementary school.

Gilbert and Bush (1988) examined the recognition, availability and use of manipulative materials among primary teachers of grade 1 to 3. The results indicated that inexperienced teachers tended to use manipulatives more often than experienced teachers. To them the reason is that experienced teachers lack of training on use of manipulatives that more recent teachers have had.

According to Johnson (1993), the majority of the teachers today have not had any formal training in using manipulatives. Teachers first need to become aware of the value of using manipulatives. One of the best ways to convey the importance of manipulatives is to let teachers themselves experience hands-on learning. (p. 10). In addition, to Kennedy (1986), classroom teachers see the value of manipulatives once they have used them with their classes.

Bearing in mind the majority of elementary mathematics teachers had never experienced the use of manipulatives during any of their education or professional life, teaching how to use manipulatives is crucial for use of manipulative materials in mathematics instruction.

In the article "How teacher educators can use manipulative materials with preservice teacher" Young (1988) explained methods for instructors to introduce manipulative materials to preservice teachers which can constitute structure of the teacher training programme developed by the researcher. According to her, a preparatory activity should focus on the definition of manipulative materials to identify whether or not the instructional aids are manipulative materials. As many manipulative materials can be used for teaching single mathematical concept or skill, it is important for teachers to learn which materials are appropriate for which of the various levels of mathematical concept. After learning variety of materials can be used to teach a single concept the next activity should be reverser namely focusing on single manipulative material to teach various skills and concepts. For example base ten blocks can be used for teaching basic four algorithms for whole numbers and decimal fractions as well as place value. Clements and McMillen (1996) warn that manipulative materials are not sufficient to guarantee meaningful learning as teachers have crucial role to combine the physical actions and symbols. Therefore, to Young it is important to teach how to help children connect the physical manipulation of materials with written symbols by focusing step by step teaching procedures that enable a child to see that written symbols are simply way to record the results of manipulating materials. Taking into consideration the limited school budgets it is important for teachers to learn to develop inexpensive manipulative materials. Another useful activity is to teach how to use manipulative materials with children for evaluation purpose. In order to see whether or not the teachers

effectively use the manipulative materials, let teachers to prepare lessons and teach the lesson to other teachers.

Trueblood (1988) developed a model that fit almost any type of program configuration and hence could serve as a point of departure for teaching to use manipulative materials more effectively. To him, this is multidimensional task and includes selection and use of manipulatives that correctly represent the mathematical concepts they must teach, assessment of children' thought processes as they use manipulatives to form mental images of mathematical concepts, and planning and management of mathematics instruction that involves manipulatives.

The model designed for prospective teachers includes first learning how a particular manipulative is used with familiar mathematical concept than how that manipulatives help them to learn an unfamiliar or forgotten concept, relationship or operation, and finally analyzing and discussing the rationale underlying the instructional process and what mental imagery the manipulative helped them formulate.

To Trueblood (1988), prospective teachers use manipulatives in their teaching in the same manner in which they are taught. Thus for the researcher it is important to observe the real class environment of the participants after having training on how to use manipulatives for identifying how they use manipulatives in their classes and how this affect their view points regarding the use of manipulatives in teaching mathematics.

Selecting the appropriate manipulative material is not the only decision that teachers need to make once the teacher is ready to use them in classroom he/she should consider the suggestions about how to use manipulative at the right time and in the right way, since it is not easy to use concrete materials well and it is easy to misuse them.

According to Reys (1971), failure to select appropriate manipulative materials and failure to use them properly can destroy their effectiveness. Therefore, when planning to use manipulative materials the teacher should consider pedagogical and physical criteria in selecting manipulative materials, construct activities that provide multiple embodiment of the concept, prepare in advance for the activity: teacher

should make trial run, prepare the pupils: provide necessary directions for activity, prepare the classroom: be sure that all required manipulatives are on hand, encourage pupils to think for themselves and group interaction, ask pupils questions, allow children to make errors, provide follow up activities, evaluate the effectiveness of material after using them and exchange ideas with colleagues. But should not use manipulative materials indiscriminately, d make excessive use of manipulative materials, hurry the activity, rush from concrete to abstract level and provide all the answers.

Johnson (1993) in the article entitled "Manipulative Allow Everyone to Learn Mathematics" recommended teachers *start slowly* by selecting one of two topics in which they will incorporate the use of manipulatives, *make commitment* thus if the lesson does not unfold as you had planned, don't give up, reflect on what went well and what did not work and make necessary judgments, *give students "play time"* bearing in mind that *i*f students have not had the opportunity to play with the manipulatives, then trying to teach a concept will be very difficult, if not impossible, help students in transition from concrete to abstract since use of manipulatives does not mean elimination of algorithms, listen students' comments and be aware that *manipulatives take more time but* the quality of learning is emphasized, not the quantity and infact in the course of a school year, the same amount of content is actually presented because less time is spent.

According to Joyner (1990) teachers need management guidelines to use manipulatives. In the article "Using Manipulatives Successfully" she stated a guideline which can be applied to all materials and grade levels. To her, firstly free exploration is a necessity whenever new materials are introduced. Secondly teachers should facilitate distribution of manipulatives by packaging the materials according to purpose of the lesson teacher since students do not wait well. Later teachers should clearly establish the goals of the lesson and how students may use the material. If teachers do not have a clear understanding of why the materials are important to the lesson they are unable to help students to make the connections from models to an internalized idea. Next teachers should prepare simple and clear guidelines to students for what is acceptable and not acceptable by using manipulatives. Finally teachers should *model the use of materials and "think aloud"* about what they

represent. When they see their instructors using manipulatives, students are more likely to value manipulatives and to use them in their own explorations. Ross and Kurtz (1993) were in the opinion that teachers found lessons involving concrete materials difficult to implement and manage therefore they suggested teachers first make clear the lesson objective in their mind second prepare students and materials for effective use of the materials thus significant plans have been made to orient students to the manipulatives and corresponding classroom, third do not forget the fact that active participation of each students is essential for successful use of manipulatives as teaching tools and al last evaluate process not just product while planning lesson involving use of manipulatives.

As a result we can say that besides having crucial role connecting mathematics in manipulatives and abstract knowledge, they have important responsibilities while using manipulatives including selecting appropriate manipulative for student developmental level and objective of the lesson, well planning of lesson and evaluating students' learning. Thus their role is difficult than traditional teaching.

With the help of information provided under this part the researcher gave brief information about what to do, not to do and difficulties that one can face with while using manipulatives to the participant teachers during the training period. .

2.5. Effects of the use of manipulative materials in the classroom

The National Council of Teachers of Mathematics (NCTM) Curriculum Evaluation Standards for School Mathematics (1989) make following assumptions that favor the use of manipulatives in grades level 5-8:

- *Every classroom will be equipped with ample sets of manipulative materials and supplies (eg: spinners, cubes, tiles, geoboards, pattern blocks, scales, compasses, scissors, rulers, protractors, graph paper, grid-paper, and dot-paper).*

- *Teachers and students will have access appropriate resource materials from which to develop problems and ideas for explorations* (NCTM, 1989, p.67-68).

In addition "*teachers' knowledge of ability to use and evaluate instructional materials and technology*" was stated as a professional requirement for teachers (NCTM, 1991, p.124).

Like NCTM, MoNE (2009) recommends the use of manipulative materials through grade 1 to 8 in all elementary classrooms with the development of new curriculum.

The belief that manipulative materials enhance the learning of mathematics has gained much validity from learning theories such as Piaget, Dienes, and Bruner. These theories strongly support the idea that children need physical involvement, which might be provided by hands-on experiences with manipulatives, in order to add new ideas to their cognitive structure (Fennema, 1973).

Piaget proposed a comprehensive theory of cognitive development that encompasses individual growth from birth to maturity. He believed that cognitive development occurs in four stages; Sensorimotor Stage (birth to age 2), Preoperational Stage (ages 2 to 7), Concrete Operational Stage (ages 7 to 11), and Formal Operational Stage (age 11 onwards). It is not possible for a child to jump over or miss a stage or by-pass a stage as in a regular sequence one must go through each stage. While passing through these stages individuals first use physical actions to form schemas and then use symbols to form schemas. Children in the concrete operational stage are capable of learning with symbols but only if those symbols represent actions the learners done previously. This means that up to concrete operational stage some of the mathematical ideas should be taught at the elementary school. Moreover, according to Sowell (1989), children generally progress in understanding mathematics ideas by participating in concrete, concrete-abstract, and pictorial-abstract learning experiences prior to the purely abstract exercises. Thus, learning experiences should be designed parallel to the sequence of cognitive development stages. And in the elementary school, children learn mathematical ideas through concrete representations. Translation of this cognitive development theory to

instructional practice indicates that learning environments for children at various developmental levels should include both concrete and symbolic models of the ideas to be learned, with special attention given to ensure a major emphasis on those kinds of experiences that represent the predominant type of orientation (concrete or symbolic) most appropriate to the development of schemas at the various developmental levels (Fennema, 1972). Students who see and manipulate a variety of objects have clearer mental images and can represent abstract ideas more completely than those whose experiences are meager (Kennedy, 1986).

Dienes and Golding (1971) advocated the use of manipulative materials by children. The Dynamic Principle, Perceptual Variability Principle, Mathematical Variability Principle, and Constructivity Principle are the four basic components of Dienes's theory. According to him, students direct interaction with the environment, multiple and varied experiences were helpful and necessary for the learning of mathematics.

Brunner (1966) suggested that things can be represented in one of the three ways; enactive, iconic, and symbolic. If we provide the opportunity for students to interact with their environment in such a way that they join a set of two objects with a set of three objects and determine that there are five objects than student's experience iconic representation. In enactive representation student see a picture of two objects, a picture of three objects and a picture of five objects. When students write 2+3=5 then symbolic representation occurs.

Learning theories developed by Dienes, Piaget, Skemp, and Brownell suggest that children whose mathematical learning is firmly grounded in manipulative experiences will be more likely to bridge the gap between the world in which they live and the abstract world of mathematics (Kennedy, 1986). This means that children who use manipulative materials effectively can both understand the meaning of mathematical ideas and apply these ideas to real world situations.

According to Fennema (1972), most of the mathematical ideas that are taught in the elementary school can represent at least two types of models; by a concrete model or symbolic model to the learners. If children are given freedom, they will select the model that makes the idea more meaningful to them. They select concrete

models because of their novelty and because they make mathematical ideas meaningful. While children become aware of inefficiency of concrete models in problem solving, they prefer to use symbolic model. Therefore an effective teacher will carefully observe children and attempt to determine which models are more meaningful and acceptable to the children concerned.

In the last 30 years more than 100 studies have been conducted to examine the effectiveness of the manipulatives to teach various mathematical concepts. According to Barnett & Eastman (1978), the results of manipulative use in mathematics are equivocal as there is a contradiction in terms of students' achievement and attitudes toward mathematics. In the following section literature related to effects of use of manipulatives on students' achievement and attitudes toward mathematics was briefly presented.

Suydam and Higgins (1977) reported that lessons incorporating manipulatives are more likely produce greater mathematics achievement than lessons not incorporating manipulatives (as cited Gilbert & Bush, 1988).

Parham (1983) analyzed sixty-four research studies with elementary school children. He found that achievement scores of elementary students who had used manipulatives were decidedly greater than those of students who had not. However, the effectiveness of manipulative materials decreases as the grade level increases.

Sowell (1989) by using meta-analysis of results of 60 studies from 1954 to 1987 determined the effectiveness of mathematics instruction with manipulative materials. Results of this meta-analysis indicate that long-term use of manipulative materials by experienced and knowledgeable teachers about use of materials increase mathematics achievement and students attitudes toward mathematics. Kennedy (1986) reported that "Although no single study validates the claim that children should use manipulative materials as they learn mathematics; the collective message garnered from many studies is that the materials are worthwhile."

From the results of study with 7th grade students Threadgill, Sowder and Juilfs (1980, as cited in Scheer, 1985) concluded:

…achievement in mathematics can significantly interact with manipulative and symbolic modes of instruction. Students with very low scores on the mathematics

concepts and Mathematics Problem Solving Tests received higher scores on the achievement posttest when instruction included manipulative materials… (p. 373).

Furthermore; the assurance of a child who is using his fingers (the most omnipresent manipulative materials), or any other manipulative material that he knows well, results in the belief that mathematics has meaning; mathematics is not just an abstract game played according to strange, unknowable rules that originated in the mysterious world of adults (Fennema, 1973). Teacher can gain insight into children's thinking while children demonstrating their ideas with manipulative materials. This helps teacher to understand whether children learn subject or not.

Driscoll (1984) stated that all levels of students need experience with concrete materials to understand rational numbers.

Lessons using manipulative materials have a higher probability of producing greater mathematics achievement than do lessons in which such materials are not used and achievement is enhanced across a variety of topics, at every grade level K-8, at every achievement level, at very ability level are the evidences of the research of Suydam (1984) concerning achievement :

Different to Spross (1964), Suydam (1984) stated that demonstration is sometimes at least as effective as directing children attention to important mathematical ideas is easier when teacher is in control of the materials. Moreover, while using manipulatives one should consider that not all children need to use manipulatives for the same amount of time.

Similarly, Herbert (1985) strongly advocated the use of manipulatives, since they motivate students, stimulate them to think mathematically, and also introduce "big" ideas in mathematics.

A study of Raphael and Wahlstrom (1989) showed that use of instructional aids was related to the students' achievement in case of geometry, ratio, proportion and percent. They stated that teachers who reported occasional use of a variety of aids in geometry were more experienced, whereas teachers who reported extensive use of aids were less so. Additionally, teachers who reported emphasis on or the use of aids or applications in ratio, proportion, and percent were also more experienced.

To Balka (1993), manipulatives in the mathematics classroom help children at all grade levels understand processes, communicate their mathematical thinking, and extend their mathematical ideas to higher cognitive levels. He was stated that "*the use of manipulatives allows student to make the important linkages between conceptual and procedural knowledge, to recognize relationships among different areas of mathematics, to see mathematics as an integral whole, to explore problems using physical models, and to relate procedures in one representation to procedures in an equivalent representation. Only time and new assessment techniques will tell whether manipulatives have improved the mathematical deficiencies of our students. Classroom teachers who are now providing students with opportunities to make mathematical connections via manipulatives say that the answer will be "yes, they do understand!*"" (p.22)

According to Yeatts (1991), the general consensus was that manipulative materials help provide a strong basis for conceptual learning and are recommended to be used by all students. Manipulative materials were very effective for handicapped students, since they often benefit from an active learning approach. They can also be used with special students to assist them in organizing their thinking so that they can begin to see relationships or follow a computational procedure. Use of manipulatives can also be valuable for students in need of remediation. These materials are also useful tools for gifted students as these students pass through the concrete stages of learning much more rapidly with the help of manipulative materials. (Yeatts, 1991)

To Heddens (1997), using manipulative materials in teaching mathematics will help students learn to relate real world situations to mathematics symbolism, to work together cooperatively in solving problems, to discuss mathematical ideas and concepts, to verbalize their mathematics thinking, to make presentations in front of a large group, that there are many different ways to solve problems, that mathematics problems can be symbolized in many different ways, and they can solve mathematics problems without juts following teachers' directions.

Sobol (1998) particularly analyzed whether or not use of Algebra Tile manipulative affects the students' learning of algebraic concept of zero and four

operations with integers and polynomials in 7^{th}, 8^{th}, 9^{th} grades. The result of the study showed that using algebra tile has significant effect on learning of mentioned algebraic concepts however there is no significant differences in students' attitudes toward mathematics and no change in student interactions in classroom. Goins (2001) also investigated the effects of using algebra tiles on students' learning of polynomial multiplication. Three methods of instruction, manipulative teaching method in which teacher use Lab Gear, Algebra Tiles and Algeblocks; visual teaching where pictures and graphs are used and non-visual/ non- manipulative teaching method were implemented throughout South Caroline in United States. She found that there was a statistically significant difference between the non visual / non-manipulative and the manipulative teaching methods both in skill data and the understanding data. According to her, the use of manipulative had a positive effect in learning the algorithm of multiplying binomials and extending to the general situations of multiplying polynomials. The students who were taught using the manipulatives method were better able to explain the process of multiplying polynomials in a written paragraph. Moreover, manipulatives provided the opportunity for students and teachers to integrate content from one concept into another.

Furthermore, Getgood (2001), assessed student understanding of Greatest Common Factor (GCF), Least Common Multiple (LCM) , Prime Factorization (PF) using a manipulative, Factor Blocks^{TM}. She suggested that the regular use of Factor Blocks during the two-week unit of study led to increased understanding of GCD, LCM and PF on tests. Thus, this supports the use of manipulative Factor Blocks in the mathematics classroom to teach fraction skills and related number theory concepts.

Smith (2006) tried to determine the effectiveness of using concrete versus virtual manipulatives in expanding polynomial factors in algebra and using color chips to illustrate addition and subtraction of integers by analyzing 5th grade of 39 students' achievement and attitudes toward use of virtual and concrete manipulatives and observing students' on- task behavior within two-week period. Although there was no significant difference in achievement of students in both groups students preferred virtual manipulatives. This study revealed that both concrete and virtual

manipulatives had a positive impact on student learning of addition and subtraction of integers and polynomial factors. However, students' choice of virtual or concrete manipulative may impact their attitude toward learning new algebra concept and on-task behavior.

Brown (2007), examined the impact of using computer-simulated (virtual) manipulatives (fraction bars) and hands-on (concrete) manipulatives (pattern blocks) on 48 sixth grade elementary school students' learning skills concepts in equivalent fractions and attitudes toward using manipulatives. Students got the instruction with concrete manipulatives out- performed students who received instruction with virtual manipulatives. In addition, they preferred virtual manipulatives rather than concrete ones but used of both methods enhance the learning environment in elementary mathematics classroom.

Allen (2007) examined the effect of use of manipulative, pattern blocks, on 5^{th} grade of 23 students' understanding of interior angels of polygons over a three day course. She declared that students showed more interest and enjoyment when using manipulatives, developed more self-confidence in their math skills and there was a significant change in the experimental group scores with an 85% confidence level. Allen recommended that using manipulatives gives students a better understanding of basic math skills and seems to hold their interest and help them to enjoy learning.

With the use of manipulatives, learning mathematics is not involving rote memorization of rules and procedures anymore. The teacher no longer is the only source of information in the class. Students explore mathematical ideas behind the manipulatives and bridge the gap between the abstract world of mathematics and real world. Although children can and do make very worthwhile discoveries, such as patterns and sequences, the best use of learning aids can not be left to chance. Learning aids are aids, they are not the whole instructional program (Spross, 1964). Researches besides suggesting instruction begin concretely they also warn that concrete manipulatives are not sufficient to guarantee meaningful learning (Clements & McMillen, 1996). To Szendrei (1996), teachers must see that "*educational*

materials cannot achieve in themselves the teaching of mathematics. Mathematics is a value added to the material". (p. 427)

According to Wiebe (1983), manipulatives did not always succeeds because of the following reasons: child no developmentally ready for the concept being not mastered of prerequisite concept, too abstract model for the student, shift of instruction to symbolic before the child has developed the cognitive concrete model to embrace the new concept, and the gap between the model and its symbolic representation is too large.

In the article entitled "Manipulatives Don't Come with Guarantees", Baroody (1989), mentioned that simply using manipulatives does not guarantee meaningful learning. Manipulatives may not get the job done or they even, may make a mess of things if they are used inappropriately or without skill. He also concluded that since we are still learning about what manipulatives should be used, how to use them effectively, and when they need to be used, we must be aware of the importance of keeping an open mind about using manipulatives.

Holt (1982) examined the effects of Cuisenaire rods in learning mathematics concept and stated that "*…were excited about the rods because we could see strong connections between the worlds of numbers. We therefore, assumed that children, looking at rods and doing things with them, could see how the world of numbers and numerical operations worked. The trouble with this theory is that [my colleague] and I already knew how the numbers worked. We could say 'Oh, the rods behaved just the way numbers do.' But if we hadn't known how numbers behaved, would looking at the rods enable us to find out? Maybe so maybe not*" (p. 138-139). This means that students can see or can't see the same picture that the teachers see when they close their eyes when using manipulatives. Moreover, Holt (1982) found that children who already understand numbers could perform the tasks with or without the blocks: "*But children who could not do these problems without the blocks didn't have a clue about how to do them with the blocks… They found the blocks as abstract, as disconnected from reality, mysterious, arbitrary, and capricious as the numbers that these blocks were supposed to bring to life."* (p. 219).

According to Heddens (1997), although the manipulative materials promise students to learn mathematical concepts, if they are improperly used they can convince students that two mathematical worlds exist- manipulative and symbolic.

Kamii, Lewis and Kirkland (2000), examined which manipulatives are good to use, how they are best used and why. To them, "*mathematics is not in the manipulatives, the value of the manipulative depends on how it is used by the child to solve problems*" (p 27). They recommend use of tangrams for spatial reasoning. However do not recommend use of counters for addition and subtraction problems as counters do not allow children to use their own representation. Like counters they also do not recommend use of balance in mathematics to show 3+ 5= 8. According to them "*balance is a physical phenomenon, is not the same thing as the logicomathematical relationship of equality. Balances may therefore be useful to teach measurement of weight, but they are completely useless for addition*"(p 28) Moreover, base-ten blocks and unifix cubes are not useful for teaching place value "carrying" and "borrowing". From conversation with 4-year old they declared that there is no such thing of "concrete numbers". Two cookies are concrete and observable, but the number "two" is neither concrete nor observable.

Rust (1999), studied with 21 first grade students in order to indentify which teaching method mainly manipulatives or standard curriculum best allowed students to learn first grade math concept. At the end of the study it was found that students taught with textbook got higher score than students taught by manipulatives although they seemed to enjoy the manipulative and hands on learning more than the bookwork.

In Turkey, not much study was done regarding the effect of use of manipulatives in terms of students' achievement and attitudes toward mathematics. Bayram (2004) investigated the effect of instruction with concrete models and gender on eight grade students' geometry achievement and attitude toward geometry. 106 students were participated the study and concluded that use of manipulatives with cooperative learning and discovery learning has higher achievement and there was no change in attitudes toward geometry. Most of the students' responses about the use of concrete models were also positive. They mentioned that they learn better when

they can manipulate and see an object rather than a two-dimensional drawing on the chalkboard. While they were manipulating the materials they were learning, and they liked active learning. They felt that they remembered the information better because they used concrete models in the learning process.

Erdoğan (2007) compared the effect of the use of the physical manipulatives; seven pieces mosaic, geoboards and origami; with self-metacognitive questioning versus manipulative without self-metacognitive questioning on the knowledge of acquisition of 220 6^{th} grade students in polygons. At the end of the study it was found that there is not a significant difference between manipulative with self-metacognitive and manipulative without self-metacognitive group. However, use of the physical manipulative affected students' learning positively in terms of learning definition and properties of polygons as while they are learning they enjoy lesson and give their attention easily.

Tuncer (2008) compared the teaching supported by material with the traditional teaching on students' achievement of 8^{th} grades students on Pascal triangle and binomial expressions. Results showed that students taught by material got higher score than students in traditional teaching.

Yolcu and Kurtulus (2010) examined the improvement of twenty 6th grade students' spatial ability trough the use of concrete materials (unit cubes), computer practicing and paper representation. Students' pots-test score was higher than the pre-test scores. Therefore, researchers recommended teachers give importance to conceptual understanding and use of concrete materials while learning three-dimensional geometry.

2.6. Factors effecting use of manipulative materials in classroom

Teachers play an important role in creating mathematics environments that provide students with representations that enhance their thinking. Teachers' beliefs about mathematics, how students learn mathematics may influence how and why they use or not use manipulatives even if they have learned appropriate strategies for using manipulatives (Moyer, 2001*).*

Teachers' attitudes and beliefs about mathematics, teaching of mathematics and how children learn mathematics influence their teaching practice and also determine the structure of their classroom. "*Teachers are influenced by teaching they see and experience*" is the one of the assumptions of Professional standards for Teaching Mathematics (NCTM, 1991; p. 124). In addition, according to Thompson (1984), teachers' believes, views, and preferences about mathematics and its teaching, played a significant role in shaping their instructional behavior. Therefore, it is important to examine the perceptions of teachers about the use of manipulatives in the classroom.

Krug (1988) investigated the relationship of elementary teachers' use of manipulative materials for mathematics instruction with teachers' hands-on training in the use of manipulative materials, recency of training, teacher attitudes toward mathematics and use of manipulatives, and other school variables (school climate, principal's attitudes, district policy, years teaching at the school) and the use of manipulative materials in class environment. The result of the study revealed that teaching experience, number of years teaching at particular school, and attitudes of the school principal did not have a significant relationship with teachers' use of manipulatives. But recency of manipulative training, teachers' attitudes toward mathematics and using manipulative materials, the grade level and district policy did have a significant relationship with use of manipulatives. In this study the use of manipulative was approximately the same as in 4^{th} and 5^{th} grade but decrease as the grade level increased until the third. According to them, this could be the effect of random sampling. .He recommended that district policy should encourage teachers to use manipulatives by providing opportunities for ongoing training every few years since teachers that have recent training in use of manipulative materials in both universities and in-service training will use more materials in their mathematics instruction. This is similar to the result of Scott's study (1983).

Despite to the fact that the uses of manipulative materials have been supported for 200 years by educators the arguments have remained much the same over that period of time and the teacher have resisted using these devices. To O'Shea (1993), the question of resistance center on two issues. The first is the commonly held belief that mathematics, at heart, is a pure, abstract, deductive and solitary

endeavor. Thus according to Szendrei (1996) a teacher who hates using concrete materials can make the following remark: "*Mathematics is abstract. We would like to create abstract concepts in pupil's mind. They will intermix concrete objects like blocks, sticks, and so on with the mathematical concepts*" (Szendrei, 1996; p.429). The second factor centers on teachers' perceived responsibility to cover the curriculum. (O'Shea, 1993) To Herbert (1985), many teachers often claim that there is not enough time to use manipulatives, using manipulatives is same as playing games and also it is difficult to manage with large number of students. Like Herbert, Ross and Kurtz (1993) also mentioned that teachers have been told manipulatives are motivating and are conductive to the concrete kinds of learning that lay a sufficient foundation for abstract thought, yet some have found lessons involving concrete materials difficult to implement or manage.

Hatfield (1994), looked at elementary (K-6) cooperating teachers' self-report familiarity with, availability of, and use of 11 common manipulative devices (such as pattern blocks, Cuisenaire Rods, geoboards, counters, unifix cubes, Base-10 blocks, number/math balance, bundleable materials, tangrams, fraction bars and attribute blocks) and their perceptions about factors to consider when using manipulatives to teach mathematics. The results indicated that approximately 70% of the cooperating teachers participating in the study were familiar with 8 out of 11 manipulative devices and these teachers had access to 88 % of the manipulatives. The use of manipulative materials decline as the grade level increased from kindergarten to sixth grade. According to the study, availability, teacher competency management of manipulatives, transfer of learning, classroom control, time factors, and students play with them are the factors that teachers consider whether or not to use manipulatives for instruction. 81 % of the participating teachers indicated that availability of device as the "most important factor" and also teacher competency and transfer of learning from concrete to abstract level were ranked second in terms of "most important factor" to consider when using manipulatives.

Teachers have a crucial role in developing students' thinking with the help of manipulatives. Of course, just using manipulatives doesn't guarantee the success. In order to understand effective use of manipulatives we have to look at the total instructional environment that teachers' image of what they intend to teach and

students' images of the activities in which they take part. Moreover, to Moyer (2001), teachers' beliefs about how students learn mathematics might influence how and why they use manipulatives as they do.

In a study of 52 secondary schools in the South Western suburbs of Sydney researchers Howard, Perry and Lindsay (1996) try to find the answers of some questions two of which are; how are these manipulatives used? And what factors influence the choice of secondary mathematics teachers to either use or not use manipulatives in their mathematics lesson? Results indicated that the use of manipulatives in secondary schools is low particularly compared to such use in primary mathematics lessons. Teachers use manipulative materials because they believe that the materials benefit students' mathematics learning and students enjoy them. In addition, school mathematics policies and the prescribed syllabus appear to have little impact on most teachers' use of manipulatives in their mathematics lessons.

Howard, Perry, and Tracey (1997), continued to investigate the teachers' beliefs about mathematics learning and teaching. In the paper "Mathematics and manipulatives: Comparing primary and secondary mathematics teachers' views", they compared primary and secondary mathematics teachers' responses about their use of manipulative materials in mathematics lessons. The results of the study were similar with findings of Howard, Perry and Lindsay (1996). However, they discovered that although the respondents agree that manipulatives benefit students' learning and students enjoy them there were differences between primary and secondary teachers in the ways they use manipulatives in their classroom. Compared to their use in secondary schools, manipulatives were used in much more as the students wish, for students to check their work and for remedial support. The use of manipulatives was decreased in secondary schools and the structure of secondary schools, with their rigid timetables, movement of students and teachers around the school and firm, school wide program may be the reason of the decrease of use of manipulatives in secondary schools. Another result of the study was both primary and secondary teachers use manipulatives in their lessons as they most believe that materials benefits students' learning and students enjoy using them. To them, school

mathematics policies and prescribed syllabus have minimal impact on their use of manipulatives in mathematics lessons.

According to Thompson and Lambdin (1994), students' images of the activities in which they are asked to engage can affect way of teachers' using manipulatives. Like Thompson and Lambdin, Hinzman (1997) stated that students' attitudes is a major barrier to use of manipulatives at the upper grade level since they see mathematics as a body of technical algorithms and believe that there is always a rule to follow in mathematics. Therefore, they want to be told the rules and resist the original and creative thinking required by an activity oriented program (Hinzman, 1997).

Ernest (1994) developed a project in order to enrich algebra and geometry programs through the utilization of manipulatives. In this project, participants were attended in a week long intensive training workshop and year-long follow up activities were done. According to the participant teachers, more time was needed for planning and more class time was needed when manipulatives are used but both students' participation, interest, and achievement is enhanced. At the end of the project, it was clear that manipulatives made a positive difference with the teachers and students.

To Trueblooed (1988), prospective teachers resist using manipulatives because of lack of confidence in their own ability to use manipulative materials correctly and the general belief that children will become too dependent on these materials so will not master basic computational algorithms and related concepts. According to him, the latter one seemed to be related to a lack of confidence in helping children make the transition from the concrete to abstract.

In the study of "the use of manipulatives in secondary school mathematics classroom", Gordon (1996) aimed to explore whether or not, and in what ways secondary mathematics teachers, teacher of grade 9 to 12, use manipulatives in their instructions. To examine the research questions a twelve-item researcher made questionnaire were distributed to the 228 secondary mathematics teachers in Peninsula region of Hampton Roads area of Virginia. 129 teachers from 6 private schools and 7 public school districts returned the questionnaire. This study showed

that although over half of the respondents stated that they use manipulatives in reality they do not use them very frequently. But it was interesting that same manipulatives for decades such as rules/meter sticks, protractors, compasses and geometric solids are still most used in contracts to the items such as algebra tiles, mira, geoboards, and tangrams. This study revealed that a great number of teachers believe that manipulatives have a valuable role in the classroom but others still believe that manipulatives have no place at the secondary level. In addition, analysis of responses indicated that teachers felt so strongly about the use of manipulatives were of the opinion that manipulatives were great ideas helping students understand abstract concept, the use of manipulatives made classes more interesting and allowed for students to be able to retain the concepts over a greater length of time, and the use of manipulatives in word problems and in the review of material helped to solidity the concepts in the minds of students. Gordon (1996) mentioned two primary viewpoints for the reasons that teachers to not to use manipulatives as "*teachers that did not necessarily disagree with the use of manipulatives felt that they have reasons beyond their control for not using manipulatives such as availability, not have training on how to use manipulatives, did not have time in the curriculum to use manipulatives, and had classrooms where manipulatives were destroyed. The others have personnel and within their control reasons for not using manipulatives. These teachers believe that manipulatives added no value to instruction and that manipulatives caused the concepts to get lost or become more difficult for students to comprehend and also caused students to become bored with the instruction and in turn lose interest in the subject*" (p. 31). Most of the participants of the study did not use manipulatives during student assessment as to these teachers manipulatives helped students go from the concrete level to the abstract level, and since assessment in most secondary mathematics courses is done at the abstract level, manipulatives should no longer be necessary. In addition, they thought that assessment should be a mirror of the real world and because of that, manipulatives should not be permitted. Furthermore, being under district wide assessment practice was other reason for not using manipulatives during assessment of students.

According to Moyer (2001), teachers play and important role in creating mathematics environments that provide students with representations that enhance

their thinking and stated that "*yet even if teachers have learned appropriate strategies for using manipulatives, their beliefs about how students learn mathematics may influence how and why they use manipulatives as they do*" (p 178) . In the article "Are We Having Fun yet? How Teachers Use Manipulatives to Teach Mathematics" the researcher tried to investigate how and why teachers use manipulatives through observation, interviews and self-report data of 10 middle grade teachers which of six teachers taught sixth grade, three taught seventh- grade and one taught seventh and eighth-grade classes. "Fun math" and "real math" are the two categories that the researcher identified through the data analysis. Teachers defined "fun math" as "games", "extra-activity", "enrichment" and "a reward for behavior". They defined "real math" as lesson segments where teachers taught rules, procedures and algorithms using textbooks, notebooks, worksheets, and paper-and-pencil tasks. These two categories reflected in classroom practices in terms of the use of manipulatives such as teachers use manipulatives as students enjoy in learning by using manipulatives or use as a reward for appropriate students' behavior. Results showed that for many teachers decision to use manipulatives were based not on the appropriateness of representation for particular mathematics concept but on whether or not students had behaved appropriately during previous lessons where manipulatives used. The distinction of "fun math" and "real math" also effected the parts of individual lessons for example, the manipulatives may be used for exploration at the beginning or "fun math" part of the lesson, or they may be used in an activity or game after the mathematics content was taught; but during the teaching of specific skills or content, paper-and-pencil methods were used to teach and practice "real math". Therefore, participated teachers often use manipulatives at the end of the class period, the end of the week on Fridays, or the end of the school year when district objectives were completed. This revealed that manipulatives seemed to be used only if there was extra time. Similar to Joyner (1990), Moyer also stated that '*by allocating specific days and times to use manipulatives, teachers sent a clear message to their students about the importance of manipulatives in mathematics instruction*" (p. 189). For teachers participated in this study coverage of state curriculum objective was an important goal and they did not clearly see how manipulatives could be used to teach these objectives as efficiently as they had

taught the objectives using paper-and-pencil approaches. Moreover, observations revealed the fact that although teachers gave verbal assent to the notion that manipulatives could be used to teach mathematics concepts, their actual lessons reflected traditional teaching routines with manipulatives used primarily to supplement.

According to Moyer and Jones (2004) for some teacher decision to use or not use manipulatives are based on the amount of control they believe they will be able to maintain in their classrooms. For others, the decision to use manipulatives is based on their perception of the usefulness of each individual manipulatives.

Jones (2010) examined the views and use of manipulatives by secondary school mathematics teachers (grade 9 to 12) to understand how and why they chose or not to choose them in their teaching by interviewing 6 teachers. He identified that teachers' views of and experience with manipulatives influence use of manipulatives in secondary mathematics classes and teachers do not use manipulatives due to have limited understanding of mathematical concept behind the manipulative, lack of experience, lack of teacher support in using manipulatives and belief that manipulatives are more suitable for elementary grades than for advanced mathematics. Time was needed for students to become familiar with manipulatives before considering them a valuable tool and for teachers to feel confident to use them. In addition, teachers needed guidance and training before using manipulatives in their classes. This study also identified that if students have limited or no prior experience with manipulatives the task of imposing mathematical relationship on the material is more challenging. According to the study, there is a connection between teachers' attribute value of manipulatives and how and when their students were able to use them as if teachers seemed them necessary and appropriate for the activity they make them available for the students.

Yıldız (2004), analyzed the preservice elementary mathematics teachers' views concerning the use of manipulatives in real class environment and identified that all of the preservice teachers believe that use of manipulative materials increase retention, understanding of mathematical concept, motivation of students ,prevent memorization and if used properly increase students' achievement. Besides they

declared that with the use of manipulatives in method class they better understand some mathematical concepts. Although they stated to use manipulatives when become a teacher they declared that availability of material, students play with them, reactions of both school administration, parents and students and time are the important factors for deciding to use or not use manipulatives in mathematics teaching.

Similar to Yıldız, Özdemir (2008) also explored 57 prospective elementary teachers' knowledge and skills about manipulatives and describe their difficulties regarding the use of manipulatives by analyzing journals and projects completed by prospective teachers and observations on classroom discussions during the teaching methods courses. She identified that although prospective teachers have positive attitudes towards using manipulatives, they do not have a clear idea about how manipulatives help students understand mathematical concepts particularly, they had difficulty in guiding students to establish connections between the concepts and manipulatives. Thus just have positive attitude toward manipulative is not enough for effective use of manipulatives in mathematics instruction.

2.7. Students attitudes toward use of manipulatives

Sowell (1989) by meta-analysis, analyzed the results of 60 studies conducted at various grade levels and identified that students' attitudes toward mathematics are improved when they have instruction with concrete materials provided by teachers knowledgeable about their use.

According to Yeatts (1991), manipulation of materials assists students in bridging the gap from their own concrete sensory environment to the more abstract levels of mathematics. Thus these are motivating and effective tools for students.

Hinzman (1999) examined mathematics scores of eight-grade pre-algebra students when hands on manipulative and group activities are used throughout 18 weeks of the 1995-96 school year. Responses of the survey of students showed that students enjoyed the use of manipulatives in activities and learning of algebraic concepts. Hinzman indicated that although the research did not show any dramatic

differences in grades with the class that used manipulatives and the class that did not, the overall feelings of the students and their attitudes toward mathematics improved.

The results of the study conducted by Garriety (1998), showed that based on the presentation and analysis of the data on hands-on, cooperative learning, the students showed a more positive attitude toward math and a desire to work with partner or in cooperative groups. Also students indicated a preference for using hands-on learning and the use of manipulatives rather than using traditional learning methods.

Erdoğan (2007) identified that students' opinions related with the effect of physical manipulative instruction were positive as it provides active involvement of students, increase students' excitement, they acquire knowledge by seeing other's behaviors, receiving different ideas and understanding other's point of view.

With the use of manipulatives students take active role in mathematics teaching, they are responsible for their own learning and by using manipulatives together with peers they see other students' ideas, share knowledge with each other and this results increase in students' motivation in mathematics thus affects students attitudes toward mathematics positively.

2.8. Summary of Literature Review

Manipulative materials are concrete objects requiring active involvement of students by handling, removing and used for mathematics instruction that can be teacher or student- made or commercial and vary in shape, size and color. The use of manipulatives has strong theoretical base (Bruner, 1966; Dienes & Golding, 1971; Piaget, 1968).

The uses of manipulative materials have been supported for 200 years by educators and in the last 30 years more than 100 studies have been conducted to examine the effectiveness of the manipulatives to teach various mathematical concepts. There are studies showing that the achievement level of students increase with the use of manipulatives (Bayram, 2004; Tuncer, 2008; Parham, 1983; Raphael & Wahlstrom, 1989; Sowell, 1989; Suydam, 1984; Suydam & Higgins, 1977;

Threadgill, Sowder & Juilfs, 1980; Yolcu & Kurtulus,2010). There are also studies showing that use of manipulatives enhance students' understanding of mathematical concepts (Allen, 2007; Balka, 1993; Erdoğan, 2007; Brown, 2007; Getgood, 2001; Goins, 2001; Heddens, 1997; Herbert, 1985; Yeatts, 1991; Smith, 2006; Sobol, 1998). Moreover, some studies show that with the use of manipulatives students' attitudes toward mathematics, enjoyment of learning mathematics is increased (Bayram, 2004; Erdoğan, 2007; Garriety, 1998; Hinzman, 1999; Rust, 1999; Sowell, 1989; Yeatts, 1991). However, according to Wiebe (1983) manipulatives do not always succeed and to Baroody (1989) simply using manipulatives does not guarantee meaningful learning. In addition, usefulness of manipulatives related to the mathematical concept to be taught and value of the manipulative depends on how it is used by the child to solve problems (Kamii, Lewis & Kirkland, 2000). In addition, the use of manipulatives decreases as the grade level increase (Gilbert & Bush, 1988; Hatfield, 1994; Howard, Perry & Lindsay, 1996; Howard, Perry & Tracey, 1997; Krug, 1988; Scott, 1983).

Teachers have a crucial role while using manipulatives including selecting good manipulative, planning lesson in line with the objective and students 'needs, deciding how to use them especially how to combine physical actions and symbols, language of instruction, and how to assess students' understanding. Much has been written about how to select and use manipulatives in classroom. (Burn, 1988; Clements & McMillen, 1996; Herbert, 1988; Hynes, 1986; Hollingsworth, 1990; Johnson, 1993; Joyner, 1990; Yeatts, 1991; Lewis, 1985; Reys, 1971; Ross & Rey & Kurtz, 1993; Spross, 1964; Sowder, 1976).

In Turkey, since 2004 new curricula have been developed and implemented in primary and secondary school with ongoing changes. Since mathematical concepts, due to their nature, are abstract and it is difficult for students to learn them directly mathematical concepts should be taught in line with the developmental level of students by using concrete, finite and real life examples. Therefore, MoNE urges teachers and students to use concrete materials while learning mathematics. According to Brosnan (1994), any attempt to improve the quality of mathematics teaching must begin with an understanding of the conceptions held by teachers and how these are related to their instructional practice. To Manouchehri and Goodman

(1998) what teachers knew about mathematics content and innovative pedagogical practices and their personal theories about learning and teaching mathematics affects how they valued and implement new programs. In addition, literature indicates that teacher practices in class do not solely influenced by curriculum, teachers' knowledge of mathematics, its teaching and learning and how students think and learn also affect this practice (Archer, 1999; Ball & Cohen, 1996; Ernest, 1989; Koehler & Grouws, 1992; Thompson, 1984). Moreover, to Moyer (2001), teachers' beliefs about mathematics, how students learn mathematics may influence how and why they use or not use manipulatives even if they have learned appropriate strategies for using manipulatives. According to Brosnan (1994), existing practices of teachers are important for success of new curriculum reform. Therefore, the researcher of this study is aimed to investigate the current use of manipulatives in teaching upper elementary level mathematics to see the application of current mathematics curriculum in terms of use of manipulatives. In literature there are studies investigating teachers' perception of use of manipulatives. Teachers use manipulatives as they believe that manipulatives benefit students' learning and student enjoy using them (Gordon, 1996; Howard, Perry & Lindsay, 1996; Howard, Perry &Tracey, 1997) and many of the teachers use manipulatives as rewarding (Moyer, 2001). Despite to the fact that the uses of manipulative materials have been supported for many years the teachers have resisted using these devices. Literature indicate the following factors affecting teachers to use or not use manipulatives: mathematics is pure and abstract (O'Shea, 1993; Szendrei, 1996), teachers' perceived responsibility to cover the curriculum (Howard, Perry, & Tracey, 1997; O'Shea , 1993), not enough time to use manipulatives **(**Gordon, 1996; Hatfield, 1994; Herbert, 1985), students attitudes toward use of manipulatives (Hatfield, 1994; Herbert, 1985; Hinzman, 1997; Thompson & Lambdin, 1994), teacher competency of management of manipulatives (Hatfield, 1994; Herbert, 1985; Ross & Kurtz, 1993; Trueblooed, 1988), lack of confidence in transfer of learning from concrete to abstract (Hatfield, 1994; Trueblooed, 1988), availability (Gordon, 1996; Hatfield, 1994) and manipulatives added no value (Gordon, 1996; Moyer & Jones, 2004). As one of the aims of the study is get deep insight of teachers' perspective about the use of manipulatives we can also understand what factors upper elementary mathematics

teacher consider while deciding to use or not use manipulatives. In addition, we will get elementary students' views about the use of manipulatives in learning mathematics and views about the manipulatives used during the study.

In Turkey, there are studies showing the affect of use of manipulatives on students' understanding and achievement of specific mathematical concepts (Bayram, 2004; Erdoğan, 2007; Toptaş, 2008; Yolcu & Kurtuluş, 2010). There are also studies related manipulatives and preservice teachers (Bakkaloğlu, 2007; Özdemir, 2008; Yıldız, 2004). However, there is less study related elementary mathematics teachers and manipulatives. Considering the importance of use of manipulatives in teaching mathematics in current mathematics curriculum and role of the teachers as they are the ones who decide to use and not use and how use manipulatives in their lessons, the aim of this study is to examine how and why upper elementary mathematics teachers use manipulatives together with the views of students.

CHAPTER III

RESEARCH METHODOLOGY

In this chapter the research methodology was described in detail by giving information about design of the study, context in which the study took place, participants of the study, data collection techniques, procedures of data collection, data analysis, and the measures taken to increase the quality of the study.

3.1. The overall design of the study

According to Creswell (1994), qualitative study is the inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of informants, and conducted in natural setting.

To Merriam (1998), the qualitative researchers are interested in understanding the meaning people have constructed, that is, how they make sense of their world and the experiences they have in the world. In addition, to Bogdan and Biklen (1998), qualitative researchers are not putting together a puzzle whose picture is already known, they are constructing a picture shaped as the researcher collect and examine the parts.

The qualitative design used for this study was a case study. According to Merriam (1998), in –depth description and analysis of a bounded system is a case study and case could be a single person, a program, a group, an institution, a community, or a specific policy. This study is concerned with teachers' and students' use of manipulatives in a private upper elementary school after four mathematics

teachers in this school were trained to implement manipulatives in the class while teaching mathematics in grades 6, 7, and 8 in Turkey. Therefore, the private elementary school, the specific implementation, the mathematics teachers, and the students in this school addressed a "case" which was investigated in this study. In other words, this study investigated the views of teachers and students about the use of manipulatives in upper elementary mathematics classes in a private school.

The study investigated the case in several steps. First, participant teachers were interviewed before taking training on how to use manipulatives in order to find out their teaching qualifications, experiences, their views about nature of mathematics, how mathematical knowledge gained by students ,and how they teach, their knowledge and views about the use of manipulatives in teaching mathematics and experience in use of manipulatives. Then, two-day training was given about definition of manipulative materials, how to select manipulative materials, how to use them and information on use of specific manipulatives such as geoboards, four-pan algebra balance, fraction bars, pattern blocks and algebra tiles.

After the training, the researcher requested participant teachers to use manipulatives in teaching mathematics and observe the lessons by using "Math Manipulative Observation" (Appendix A) checklist of Ernest (1994). The researcher also received students' views in 10-15 minutes about the manipulative and the activity by using "Students Evaluation Form" (Appendix B). By using this form the researcher identified whether students were familiar with the used manipulative or not, how they felt while learning mathematics with the use of manipulatives, whether the use of manipulatives was easy or not, and whether they understood the subject by using manipulatives or.

The post interview protocol was made after each implementation and aimed at exploring teachers' views about the implemented activity and the manipulative material used. The first interview took approximately 45 minutes and the post interview took nearly 10 minutes.

The details of this case study were described in the following sections.

3.1.1. The context

The study was conducted at private elementary school in Ankara. The school had the following facilities: two medium-size sport halls, two dining halls, a health centre, two computer labs, music classes, and science classes.

The average class size in the school was 20. The organization of instruction for each content area is realized by the department of each related content area at the school. The mathematics department was responsible for preparing yearly plans, daily plans, working papers, choosing test books, preparing bulletin board for mathematics and arranging activities for students.

Teachers were the members of mathematics department in the school and there were four teachers in the department. In the school grades and classes were distributed to teachers equally as each teacher has attended two classes in two grade level such as one teacher has class in grades 6 and 8 the other has class in grades 7 and 8. In addition, on rotation base teachers attend lessons of students who take lower score in sample exam of SBS on every Wednesday 8^{th} lesson to make review of lesson and solve questions.

Mathematics department was also responsible for organization of competitions, project festivals and club activities in TÜBİTAK and mind games. In addition, teachers were responsible for informing parents about students' progress and development, and give feedback and if necessary give study for students. This information sharing was done periodically via email, telephone, and personal meetings beyond school online system.

Three written examinations were implemented in one semester and after each exam, student grades together with in which topic they have problem or failed to answer were delivered to parents by the school's online system. Moreover, students' behavior in class, use of notebook, homework performance and quizzes, performance projects and portfolios were also taken into account while evaluating student performance in mathematics.

In the school all mathematics teachers were using the MoNE book, yearly plan and follow same daily plan to provide that all the classes had conducted parallel

activities while learning mathematics, same handouts and test papers were used. In addition, teachers were preparing students for SBS (Seviye Belirleme Sınavı-The Exam Assessing Students' Academic Standing) at weekends.

3.1.2. The participants

The participants of this study were four elementary mathematics teachers in a private school and their 6^{th}, 7^{th}, and 8^{th} grade students. These teachers and the private school they worked provided the settings in which this study would be conducted and they volunteered to become the participants. Therefore, for the purposes of this study, the school and the teachers were selected conveniently for this study.

3.1.2.1. Teachers

Participants in this study were four elementary mathematics teachers of grade 6 to 8. Three of them were female and one of them was male.

Although the quotes given in the following section are verbatim, names have been changed to ensure confidentiality. The pseudonyms used during the study were Alkın, Esra, Burcu and Ahmet. The elementary mathematics teachers who served as the subjects of this study were as follows:

Alkın

She graduated from Secondary School Mathematics Education Department of Hacettepe University in 2000 and has a master's degree on education programs and teaching. She declared that she did not remember what kind of courses she had taken during the university education but stated that she did not take any courses in which the use of manipulatives were taught during the university education. She has 9 years of experience and has taught to 9^{th}, 10^{th}, 11th and 12^{th} grades. This is her first year in the observed school and she is an elementary mathematics teacher of grades 6 and 7. She is also the head of the mathematics department (zümre) in the school.

Esra

She graduated from the department of Elementary Mathematics Education, Middle East Technical University, in 2004. She had taken courses on how to use materials in teaching mathematics and how to prepare activities by using materials in undergraduate years. She has seven years of teaching experience and has taught 4th, 5th, 6th, 7th and 8th grades. This year is her second year in the observed school and she is a teacher of 6th and 8th graders.

Burcu

She graduated from the department of Secondary School Mathematics Education, Boğaziçi University in 2008. She is doing her MA in Secondary School Mathematics Education at Marmara University and currently, she is working on her thesis. She has 4 years of experience and has taught grades 6, 7, 8, 9, 10, 11 and 12 so far. This is her first year in the observed school and she is a teacher of grades 7 and 8. She doesn't know how to use manipulatives in teaching mathematics as she did not take any lesson in university education and has no in-service training about manipulatives.

Ahmet

He graduated from Elementary Mathematics Education Department of Karadeniz Technical University in 2010. He had taken courses on how to use materials in teaching mathematics and how to prepare activities by using materials during his university education. He has two years of teaching experience and has taught to 6th, 7th, and 8th graders. This is his second year in the observed school and he is teaching to 6th and 8th graders. He is also the coordinator of SBS and he is dealing with selecting test books, organizing exams, sharing and discussing results of the exams with teachers, administrators and parents to find ways to help students raise their grades.

The following table summarized the qualifications and teaching experiences of participants.

Table 3.1. Qualifications and Experiences of Participants

	Qualifications	**Teaching Experience**	**Grades Taught**
Alkın	Hacettepe University Secondary School Mathematics Education (2000) M.S: Başkent University Education Programs and Teaching	9 years teaching experience in two private schools. First year in the observed school Head of the mathematics department (*zümre*)	Grades 9 ,10 ,11 and 12 In the observed school she is the teacher of grades 6 and 7.
Esra	Middle East Technical University Elementary Mathematics Education (2005)	7 years teaching experience in two private schools and a private study center Second year in the observed school	Grades 4 ,5 ,6 ,7 and 8 In the observed school, she is the teacher of grades 6 and 8.
Burcu	Boğaziçi University Secondary School Mathematics Education (2007) Master at thesis stage Marmara University Secondary School Mathematics Education	4 years teaching experience in a private course First year in the observed school	Grades 6,7,8,9,10,11 and 12 In the observed school, she is the teacher of grades 7 and 8.
Ahmet	Karadeniz Technical University Elementary Mathematics Education (2010)	2 years teaching experience in observed school	Grades 6,7 and 8 In the observed school he is the teacher of grades 6 and 8.

3.1.2.2. Students

The participant teachers' 6th, 7th, and 8th grade students were also the participants of this study. The students of 6th, 7th and 8th grade had 5, 5 and 4

mathematics classes in a week and approximately 20 students exists in the classrooms.

Table 3.2. Classes and Number of Students

Classes	**A**	**B**	**C**	**D**
6	**20**	**19**	**18**	**19**
7	**20**	**20**	**22**	**-**
8	**21**	**19**	**21**	**-**

3.2. Data Collection Instruments

In this study, the data collection instruments can be grouped under three categories as interviews, observations, and analyzing of documents consisting of annual plan, daily plan, notebooks of students, and the field notes that the researcher kept throughout the study. The data collection instruments, piloting of the instruments and how they were conducted was explained here in detail.

3.2.1. Pre-Interview Protocol

Having considered the framework built, a semi-structured interview protocol with open-ended questions were prepared in order to gather the information needed to answer the research questions. The interview protocol consisted of 16 main questions and related sub-questions. The first interview protocol was made with the aim of learning teachers' qualifications, experiences, their views about the nature of mathematics, how mathematical knowledge is gained by students, how teachers teach mathematics, teacher's knowledge and views about the use of manipulatives in teaching mathematics, and experience in the use of manipulatives. The interview protocol included questions on teacher qualifications and experiences (question 1 -4),

their past experiences as student (question 5), nature of mathematics (question 6), how students learn mathematics (question 7), how they teach (question 8 & 9), views about current mathematics curriculum (question 11, 12, & 13), views about the use of manipulatives in teaching and learning mathematics (question 14), experience in the use of manipulatives (question 15), and training attended and needed on the use of manipulatives (question 16). The interview protocol was given in Appendix C.

The first draft of interviews was prepared in Turkish by the researcher. The advisor of the researcher checked the questions in terms of clarity and content-specificity. Some questions were revised, changed or dropped.

The researcher piloted the first interview protocol with two elementary mathematics teachers in same school, one of which was 5^{th} grade with 12 years of experience and the other was a 6-8 grade teacher with 16 years experience. While piloting the first interview protocol, the researcher considered relevancy of the questions related to the research question, whether interviewees understood the questions or not, the appropriateness of flow of questions, and the timing of the interview. The pilot interview took 50 minutes and after this study, the researcher identified that sequential arrangement was needed taking the grade level into consideration, for while answering the questions the same or similar issues arose at different times, and in order for the interviewees not to get away from the question, new prompts had to be added.

The researcher also piloted the revised first interview protocol during 2009 spring semester in one of public school in Çankaya district in Ankara with one elementary mathematics teacher of grades 6, 7 and 8. The teacher graduated from Secondary School Physics Education Department of Marmara University in 2000 and had a master's degree on that area. During that pilot study, the first interview protocol was identified to be corresponding to the research questions.

3.2.2. Post-Interview Protocol

The post interview protocol consisted of 10 main questions and related sub-questions. The post interview protocol was made after each implementation and aimed at exploring teachers' views about the implemented activity and the manipulative material used. Interviews started with the question about overall opinion about the activity, and then continued with questions related to the appropriateness, strengths and weaknesses of the manipulative material used. Additionally, teachers' recommendations for the teachers who would use materials for the first time and under what conditions they themselves would continue to use manipulatives were addressed. The post interview protocol was piloted during 2009 spring semester in a public school in Çankaya district in Ankara with one elementary mathematics teacher of grade 6^{th}, 7^{th}, and 8 after the implementation of the activities. The interview protocol was given in Appendix D.

3.2.3. Observation Checklist

The researcher observed the participants' lessons. The "Math Manipulative Observation" checklist of Ernest (1994) was used in order to understand how teachers used manipulatives and how students reacted to the use of manipulatives. The observation checklist was given in Appendix A. The researcher used the "Math Manipulative Observation" checklist while piloting the study in Spring Semester of 2009.

3.2.4. Student Evaluation Form

In order to receive the students' views about the use of manipulatives, the researcher distributed "Student Evaluation Form" (Appendix B) in each implementation ten minutes before bell rang. With the help of this form, the researcher tried to identify whether students were familiar with the used manipulative or not, how they felt while learning mathematics with the use of manipulatives; whether they liked or disliked them, whether they felt like playing a game or felt that

they really learnt something, or felt both; whether the use of manipulatives was easy or not, and whether they understood the subject by using manipulatives or not. Additionally, their suggestions on the lesson were also asked.

3.2.5. Field-Notes

Apart from the above mentioned data collection instruments, during the presence of the researcher at the school, the researcher also kept "field notes" to identify the views of teachers about the implemented activity and materials that they did not mention during the interviews. The researcher used these notes as a supplement to the data collected through interviews and observations.

3.2.6. Treatment

While preparing the training, the researcher took the information presented in sections 2.2 definition of manipulative material, 2.3 what is effective manipulative, and 2.4 how to teach use of manipulative materials of chapter two of the study into consideration. According to literature review, the researcher first decided to give the definition of the manipulative materials. After giving the definition, since it was important for the teachers to know the important characteristics of manipulatives and physical and pedagogical criteria, the researcher decided to give brief information about physical and pedagogical criteria of manipulatives taking the information provided under section 2.3 what is effective manipulative of chapter two into consideration. Later how to use base-ten blocks, fraction bars, pattern blocks, algebra tiles and geoboards in teaching mathematics was explained. But while doing this, the researcher explained and exemplified that one manipulative could be used for teaching single mathematical concepts or a variety of mathematical concepts. While preparing the training materials, the researcher used both information from Internet sources and the books listed below:

- Hands on Math Ready to -Use Games and Activities for Grades (4-8)
- Start with Manipulatives for Staff Development

- Algebra Tiles for the Overhead Projector
- Teaching Mathematics: A Source Book of Aids, Activities and Strategies Third Edition
- About Teaching Mathematics: A K-8 Resources
- Four-Pan Algebra Balance
- The Mathematical Toolbox
- Discovering Geometry An Inductive Approach

In Appendix E, you can find some activities developed for this training. The researcher piloted the prepared activities to the 25 elementary mathematics teachers. Teachers were from different grade levels (1-6) and the training programme took nearly 5 hours. At the beginning of the training, the advisor of the researcher gave information about the new mathematics programme and the aim of the activity. The researcher briefly described what manipulative materials are and started to use mirror activities in order to attract the attention of participants. During the pilot study, the researcher identified that the availability of the materials was not a problem for the teachers as most of them were provided with material sets including geoboards, fraction bars and pattern blocks. The teachers in the pilot study stated that no in-service training was provided for the implementation of new mathematics curriculum and they were eager to attend such a training programme. After the pilot training, the researcher identified that activities should be in line with grade levels and covers the subjects in the mathematics curriculum.

The researcher also piloted "Math Manipulative Observation Checklist" and "Students Evaluation Form." Also the first interview and the post interview questions together with the activities in training during 2009 spring semester in one of public school in Çankaya district in Ankara were piloted with one elementary mathematics teacher of grades 6, 7 and 8. The teacher had graduated from Secondary School Physics Education Department of Marmara University in 2000 and had a master's degree on that area. During that pilot study, it was identified that the researcher might have difficulty in applying activities with teachers if the researcher requested the teachers to do their own activities and it would be difficult to observe more

teachers in different grades. Therefore, the researcher, together with the thesis committee, decided to prepare activities for teachers and do the study with 2 or 3 teachers attending grades 6, 7 and 8.

As majority of the teachers did not have any experience or training about the use of manipulative materials, at the beginning of the study the researcher decided to give 5-day training about the use of manipulative materials in teaching mathematics. However, after first interview protocol with participant teachers, the researcher realized that participants requested a short training and therefore, together with the participants the researcher decided on what manipulatives to be introduced and the time of the training.

The researcher gave a 2-day training at the end of October 2011. The training was done in 4 sessions. In the first session, the definition of manipulative and physical and pedagogical characteristics of manipulatives were given. After a 15 minutes break, the second session started with the introduction of manipulatives that existed in current mathematics curriculum. How to use base ten blocks was explained through hands-on activities in two sessions. In the last session of the first day, how to use fraction bars was taught. On the second day, how to use fraction bars and pattern blocks were explained in the first session and half of the second session. How to use algebra tiles was explained in one and a half sessions. How to use a four-pan algebra balance was explained also in one and half session.

3.2.7. Data Collection Procedures

The data was collected during 2011 fall semester. At the end of October 2011, the researcher conducted interviews with participants and gave 2-day training. Before the interview started, the researcher gave standard information to interviewees: the purpose of the study, to whom would use the interview data, and the recording technique. During the interview, the researcher took notes and tried to maintain eye contact. The researcher sometimes needed to probe when the interviewee tried to paraphrase the question to check if they understood it correctly or not. All the interviews were tape-recorded. At the end of the interview the researcher thanked for their time and effort.

After the first interview, a 2-day training was given and the participants started to use manipulatives in their classes. The participants used fraction bars, geoboards, geometry sticks, base-ten blocks, four-pan balance, paper folding activity, and paper cutting activity in teaching mathematical subjects of fractions, angles in the circles, sides relations in triangles, operations in decimal numbers, solving one unknown equations in algebra, bisector and median in triangle and Pythagorean theorem respectively.

Table 3.3. Observations' of applications and interviews

Participants	**Manipulatives**	**Grade Level**	**Observation**	**Interview after application**
Alkın	Fraction Bars	6th	One lesson hour	5 minutes
	Geoboard	7th	One lesson hour	5 minutes
	Geometry Sticks	8th	One lesson hour	5 minutes
Esra	Four-Pan Balance	6th	Two lesson hours	10 minutes
Burcu	Geoboard	7th	One lesson hour	5 minutes
Ahmet	Base-Ten Blocks	6th	Two lesson hours	12 minutes
	Geometry Sticks	8th	One lesson hour	10 minutes
	Paper cutting activity	8th	Two lesson hours	10 minutes
	Paper folding activity	8th	-	5 minutes
	Four-Pan Balance	6th	-	5 minutes

A total of 8 lesson observations were made with the aim of seeing how teachers used the manipulatives and how students reacted to their use . During the observation, the researcher took notes on questions asked by the students and teachers, revisions made by the teacher in the implementation of activities and students' and teachers' remarks on the investigated area. In addition, the researcher took photographs of students while doing the activities and used these photos while presenting the findings of the study. Moreover, in each observed lesson, the researcher distributed "student evaluation forms" ten minutes before the bell rang. After each observation, the researcher conducted a post- interview protocol with the participants in order to get their view points about the activity, the material used and students' behavior in the activity. In general this was done on the day following the observation or one day after the activity. During this post-interview protocol, the researcher took notes rather than using the tape-recorder as the participant felt uncomfortable with it.

Besides interviews and observations, the researcher also took "field notes" approximately two months period in order better understand the real views of teachers about the use of manipulatives in teaching mathematics. A schedule indicating the order of events conducted for the data collection was given in the below table.

Table 3.4. Timeline for Data Collection

Event	Date
Development of the interview protocols, activities and piloting studies	December 2008 – June 2010
First interview protocol with participant teachers	October 2011
2-day training on how to use manipulatives	November 2011
Implementation of activities by teachers & Interviews with teachers after each implementation & Students' evaluation form	November 2011- January 2012

3.2.8 Data Analysis Procedure

As Bogdon and Biklen (1998), data analysis is the process of systematically searching and arranging the interview transcripts, field notes and other materials that the researcher accumulate to increase his/her understanding of them and also enable the researcher to present what he/she has discovered to others. Moreover, data analysis process involves working with data, organizing them, breaking them into manageable units, synthesizing them, searching for patterns, discovering what is important and what is to be learned and deciding what to tell others. (Bogdon & Biklen, 1998)

Step 1 Preparing Data in Transcript Form

The researcher transcribed 45 minutes took interview notes word by word from the tapes she had recorded during the interview by using a word processing

program. The hard copy of each interview was filed in two groups; before the training and after the application.

Step 2 Categorizing Data

The researcher as a next step started generating categories to classify the collected data. While categorizing data the researcher kept in mind the following suggestions of Deys's (1993): review of relevant literature, the research question, interference from the data, and imagination and previous knowledge.

The data collected through interviews were analyzed by categorizing the data under themes according to the answers to question in the interview schedule. For this purpose, responses to the questions were grouped under the categories drawn from the framework of the study. Similar responses were grouped and different responses were added.

Step 3 Data Interpretations

After categorizing the data, the next step was to interpret them with respect to related literature.

3.3. The Quality of the Research

3.3.1. The Researcher's Role

The role of the researcher in the study was a trainer during the 2-day training period, an interviewer to realize the first and post interview protocols and an observer while teachers were doing the activities in their classes. During the interviews, the researchers did not direct the participants and applied the interview protocol. The researcher was a non-participant observer during the activities. At the beginning of the lessons, the participant teachers introduced the researcher to the class and the researcher sat at the appropriate place available in the class for observing the lesson and filling the "Math Manipulative Observation Checklist". In addition, during the activity the researcher walked around the class in order to take photographs and better understand how students used manipulatives.

3.3.2. Validation Strategies

Creswell (2007) defined "validation" in qualitative study as *"an attempt to assess the "accuracy" of the findings and best described by the researcher and the participants*" (p. 206). According to Creswell & Miller (2000 as cited in Creswell 2007) a prolonged engagement and persistent observation, triangulation, peer review or debriefing, negative case analysis, clarifying researcher bias from the outset of the study, member checking, rich, thick description, and external audits are the eight strategies that frequently used by the qualitative researchers as validation strategies. In this study, the researcher stayed at the observed school during two months. This prolonged engagement built trust with the participant teachers and they shared their real viewpoints regarding the use of manipulatives in teaching mathematics different from the views that they mentioned during the first interview protocol. In addition, the students were also accustomed to the researcher and she thought that they behaved in the observed lessons as they were in the class with their teachers. The researcher collected data through interviews, observations, analyzing documents consisting of the annual plan, daily plans, notebooks of students, and the field notes that the researcher kept throughout the study. Thus triangulation was done in this study by using different sources. In addition, following the interview the researcher submitted transcripts of the interviews to provide opportunities to clarify their ideas. Besides this member checking, the phrases that were very close to the teachers' wordings and verbatim were used in reporting the research findings. In addition to data triangulation and member checking, the details of the data collection, data collection tools and analysis were described in order to increase the dependability of the study. The researcher also clearly mentioned her role during the study and explained the effect of her presence during the observation as a limitation to the study besides mentioning other limitations. As a result, the researcher used prolonged engagement, clarifying researcher bias from the outset, rick, thick description, member checking and triangulation as validation strategies.

3.3.3 Reliability Strategies

According to Creswell (2007) employing a good-quality tape for recording and transcribing the tape enhance the reliability of the study. In this study, the first interview was tape recorded and the researcher transcribed the records word by word by using a word processing program. Thus the researcher transcribed all the interviews by herself and this enabled her to listen to them again and again and to gain familiarity with the possible codes for data analysis.

CHAPTER IV

FINDINGS

In this study the researcher aimed to investigate the views about the use of manipulatives by upper elementary mathematics teachers to understand rationale behind the use and not use of manipulatives and how they use together with the views of students.

In this chapter, firstly brief information on each participant based on the answers of interview questions relevant to the conceptual framework of the study that was explained in Chapter II was presented as an answer to fist sub research question of "How are upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics related to their views about mathematics, teaching and learning mathematics, and mathematics curriculum?". This section of "teachers' mathematics related views" was important to contextualize participant teachers' views about manipulatives and was grouped into three dimensions as "views about mathematics", "views about teaching and learning mathematics", and "views about mathematics curriculum". Secondly, the responses of participants to particular questions were presented under certain categories relevant to the main research questions across the participants in order to clearly present the similarities and differences between each other. Findings relevant to the research question of "How do upper elementary mathematics teachers use manipulatives in their classes?" were presented on activity basis and for each participant separately. While doing this how participants used the manipulatives, students' reaction; how they acted during the activity, their interaction with the manipulative and lesson; and teachers' views after the application were elaborated. The findings for the research question of "What

are the views of elementary students about the use of manipulatives in learning mathematics?" were presented for each used manipulatives separately. At the end summary of findings were presented.

While the findings were reported, related parts of the transcripts belonging to the interviews and students' views were taken as reference. Those parts were presented both in Turkish and English in order not to lose some details due to the nature of the languages. In the case of one participant, less amount of quote was used and minor editing might had been made to aid clarity and readability due to the inverted Turkish sentences.

4.1. Teachers' mathematics related views

In this part answer of first sub-research question of "How are upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics related to their views about mathematics, teaching and learning mathematics, and mathematics curriculum?" was elaborated for each participant separately.

The Participant: Alkın

Views about mathematics

She stated that "mathematics is the language of nature, language of life and you can not find anything in which mathematics does not exist."(Turkish version: *Bence matematik bir dildir doğanın bir dili hayatın bir dili yaşamda matematiğin olmadığı hiç bir şey yok*.) She wants her students to see mathematics like her. To her, mathematics is everywhere in life from time, height, weight, shopping to measurement and by showing this to students, we can make mathematics a favorite lesson of students.

Views about teaching and learning mathematics

She explained her previous learning of mathematics by using the terms "traditional way" and "doing lots of arithmetic operations on board". However, she remembered that in grade 1, 2 and 3 they used abacus, beans and sticks while learning addition and subtraction. According to her, teachers in the high school and preparatory courses for the university entrance exam affected her so much as they had good relations with her. To her, if you like your job, namely being a teacher, then you try to find ways how to teach students better , how to make the subject interesting and to make students like the lesson. But if you don't like your job, you will not behave like this. She explained the effects of previous learning experience of mathematics as a student on her teaching in her own words as: "… I am looking at my past and always think about how I can make my students like mathematics, and then, as I said before, I am looking at my past. The most important factor affecting my love for mathematics was my teachers who had a good communication with me with their warm and easy going attitudes. (Turkish version: …. *öncelikle kendi geçmişime bakıyorum Ve hep her zaman şunu düşünürüm öğrencilerime matematiği daha çok nasıl sevdirebilirim ne yapabilirim öncelikle kendi geçmişime tabiî ki bakıyorum. Ne dedim örneğin benim matematiği asıl sevdiren öğretmenlerim benimle iyi iletişim kuran öğretmenlerimdi katı davranışlar değil hani tatlı sert*.)". She wanted to be a teacher like her teachers and while teaching a subject, she empathizes with her students and thinks how she learned and dealt with difficulties.

Seeing mathematics everywhere affects her teaching style. While teaching a mathematical subject, first of all she makes real life connection by showing how this newly-learned information will be used in life or she uses materials to make the subjects more concrete and visual to students. In addition, for her just listening and taking notes is not enough for students to understand mathematics well. Mathematics can best learned by applying learned knowledge, namely by solving several questions and she stated her thoughts as "I want my students to solve a lot of questions." (Turkish version: *Ben çocukların çok soru çözmesini istiyorum*)" and because of this, time is important for her to realize everything covered in her daily plan, hand outs, test sheets and homework.

According to her, while teaching mathematics, the teacher should give information about the subject to be taught to students, and to which subject it is related. This kind of information should be given to students so that they can separate a place in their mind for the subject. She stated that connection of mathematics with real life is so important and therefore, when starting to teach a subject, she first begins by explaining how it will be used in real life. For example, while teaching the concept of positive and negative in grade 7 at first, she tried to show the place of "minus" in our life. She stated that "I am trying to explain these concepts through examples. For example, I say 'Suppose you owe money to somebody, and now you need to give money from your pocket. You have this money but you will give it, so in this case it is not your money indeed, so it is a "minus". Or, suppose you are entering a building and there are upstairs and downstairs, you can go to either one. To go to upstairs is "positive" and to go to downstairs is "minus". Or, while watching weather conditions, the speaker says that Ankara will be minus 2 tomorrow, and then you should teach what it means or where "zero" is displayed, that is, firstly we need to show minus in our daily life." (Turkish version: *Bunu bir takım örneklerle açıklamaya çalışıyorum. Örneğin borcunuz var vermemiz gerekiyor; cebinizden bir para çıkması lazım. Cebinizde var ama siz onu vereceksiniz. Sizin değil. Dolayısıyla bu bir eksidir. Veya bir apartmanın içine giriyorsunuz. Apartmanda aşağıda da katlar var girişten sonra. Aşağıya da inebilirsiniz yukarıya da çıkabilirsiniz. Yukarı çıkmak artı iken aşağıya inmek eksidir. Veya hava sıcaklığı akşam haberlerde izliyorsunuz. Ankara yarın eksi 2 derece olacak bu ne demek? Sıfır neresidir? Artı neresidir? Eksi neresidir? Yani öncelikle hayatımızdaki eksiyi öğretmemiz gerekiyor.)*

She described her role as a teacher in her own words as: "Of course I am the person teaching and they are the students learning. This is an inevitable reality but here guiding the students and to make them discover the knowledge is very important; otherwise, students feel lost and do something else." (Turkish version: *Tabii ki ben öğreten onlar öğrenen oluyor yani bu kaçınılmaz bir gerçek ama burada öğrenciye rehber olmak çok önemli. Yani bilgiyi kendilerine keşfettirmek çok önemli. Aksi takdirde kayboluyorlar ve ders dışı şeylerle ilgileniyorlar.)*

According to her, in general, mathematics is a lesson that students don't like. This is more evident in high school than in grades 6, 7 and 8. To her, students in grades 6, 7 and 8 are in transition and moulding stage and if they, as teachers, help students love mathematics, this will affect their high school and university performance. This can be done by showing students that mathematics can be learned, done and applied and that it exists in whatever they see around them and also that they can use what they have learned in math lessons all the time. In addition, real life connection and use of materials are important in this journey. She is of the opinion that the reason behind negative attitude toward mathematics goes back to even first and second grades. Students are prejudiced against mathematics and the situation worsens if students do not understand math or do exercises on mathematics.

Views about mathematics curriculum

Although this is her first year in elementary school, she knows the mathematics curriculum and tries to follow both the order of subjects and contents in line with the teachers' book. She likes the current mathematics curriculum compared to the previous ones as there are several activities and real life connections, and knowledge is presented in a concrete way to students rather than abstract. However, they can not do all the activities mentioned in the teachers' book as they have an annual plan; daily plan and they try to catch up with the planned activities and curriculum. According to her, time is important. For example, she said that in the teachers' book, an activity was said to last one lesson hour; however, in reality, it is very time consuming as you should prepare the activity, make the materials available to students and prepare students for the lesson. Thus it takes much more time than the expected time. She stated that they not only used MoNE books but also work sheets, test sheets and that they had to check whether students did the questions and if necessary to solve them in the classroom and these were not in the MoNE book.

She stated that she did not have any problems while implementing the current mathematics curriculum except doing everything that she had planned; therefore, time is important for her as she wants her students to solve several questions.

The Participant: Esra

Views about mathematics

She explained what mathematics means to her as follows: "I can define mathematics in a best way as a way of thinking and it teaches you how to think." (Turkish version: *matematiği düşünce tarzıdır size düşünmeyi öğretir en güzel öyle söyleyebilirim*). She stated that her friends thought she used mathematics everywhere consciously or unconsciously, whether it is relevant or irrelevant. To her, mathematics is something concrete but for her students it is abstract as they are not able to see mathematics in their life.

Views about teaching and learning mathematics

She stated that "actually girls act like their mothers and teachers act like their old teachers." (Turkish version: *Kızlar annelerine, öğretmenler de öğretmenlerine benzer*.) She said that she remembered the behavior of the teachers that she hated and tried not to behave like them, especially in terms of their relations with their students. For example, when her students behave in a bad manner, she does not use the words that she hated hearing when she was a student. In addition, she said: "After being a teacher, I remembered my school days memories much more. I think to myself, 'I did not like such behaviors or I liked that kind of behaviors', then I try to behave like those that I liked. (Turkish version: *Öğretmen olduktan beri öğrencilik anılarım daha bir canlandı gözümde daha net hatırlar oldum onları hatırlayıp ha evet böyle yapıldığında sinir oluyordum böyle söylendiğinde hoşuma gidiyordu gibi öyle davranmaya çalışıyorum*.)

She wants to attend the lessons of her old geometry teacher to understand her teaching style. To her, her teacher taught very well. She likened her style to opening the brain and putting the information in it so that she could understand the logic behind questions. She emphasizes this point in her own words as "Now, I am trying to use the remaining scraps of my knowledge. I say, 'Look children, this question is very simple. They are always similar. It gives us a bisector and an acute angle. This means that we will use the bisector theory from the descending lines. The figure is self-explanatory. A vertical line will be drawn. Our teacher had coded additional

drawings and associations to our minds. Now we are not teaching geometry to our students intensively, but I am trying to use associations and hints on other subjects, too." (Turkish version: *Şimdi aklımda kalan bilgi kırıntılarını kullanmaya çalışıyorum. Bakın çocuklar soru çok basit hep aynı bakın bize açıortay vermiş diklik vermiş ha demek ki açılara inen kollardan açıortay teoreminden faydalanacağız. Söylüyor zaten nelerden faydalanacağımızı demek ki dik çizeceğiz. Ek çizimler ve çağrışımları bizim beynimize kodlarlardı şimdi çocuklara çok fazla geometri vermiyoruz ama diğer konularda da bu çağrışımı ipucu vermeyi falan onları kullanmaya çalışıyorum*).

She defined her teaching style as "between modern and traditional but more like traditional since I learned mathematics with this method and as I said earlier, old students act like their teachers." (Turkish version: *modern ile klasik arasında ama biraz daha klasiğe yatkın Kendim öyle olduğum için kaçmış hani dedim ya öğrenci öğretmene benziyor diye ben öyle bir eğitim sisteminden geldiğim için.*). However, she does not want her students directly to memorize the rules. She enables her students to find the rule by asking guided questions. According to her, students should learn mathematics by having fun. She explained this point as follows: "I am trying to entertain them, because mathematics is not a subject like social or applied sciences that they see in their daily life. Of course getting them to think in mathematical terms is important but for the time being, students perceive it as an abstract thing since they can not observe its impacts on daily life directly; therefore, in order not to bore them, I am trying to be amusing and find some funny examples". (Turkish version: *Biraz eğlenceli olmaya çalışıyorum daha doğrusu çünkü sosyaldeki fendeki gibi çok daha hayattan bir konu değil tama çok işlerine yarıyor matematiksel düşünme çok önemli bir şey ama şu anda onları fark edemedikleri için çok soyut geliyor onlara onun için sıkılmamaları için daha neşeli işlemeye çalışıyorum hani dediğim gibi komik örnekler bulurum*). According to her, giving examples is very important while teaching mathematics. Therefore, she gives funny or interesting examples while teaching a mathematical subject. For instance, while teaching the subject of distinct events covered in the subject of probability, she used the example of films in which the director shoots two different ends. Thus there exist two different ends and one should take both ends into consideration while evaluating the

film but two ends can not happen at the same time like distinct events. She likes to challenge her students by asking difficult questions, each time starting from simple to more difficult ones.

She doesn't want her students to write many things on their notebooks as she disliked writing when she was a student. She uses a smart board and teaches subjects by using slide shows. She admitted that she did not use materials during this year.

According to her, discovery learning can not be done in the classrooms as the students are not accustomed to such kind of teaching and learning; thus, students cannot discover the answers on their own and explained the reason by saying "actually due to our education system, students are not able to make discoveries".(Turkish version: *Açıkçası bizim eğitim sistemimizden kaynaklanıyor. Çok keşfetmeyi beceremiyorlar*). This situation was same for her also. Therefore, she asked questions like "What will we do next?", "If we do it in this way, what is the logic behind …?", and "What operation will we do next and why?" In this way, instead of directly saying and getting students to memorize the rules, she somehow makes them discover something. In addition, she disagrees with the idea that "*everybody can learn mathematics",* which the basic principle is underlying the curriculum and she said: "I do not think that everybody can learn all the subjects of mathematics at the same level. I think they shouldn't" (Turkish version: *herkesin matematiğin tamamını aynı seviyede öğrenemeyeceğini, öğrenmemesi gerektiğini düşünüyorum*).

While preparing her lessons, she uses only the questions in MoNe books as she doesn't like the examples for introducing the unit or subject. She also uses lesson plans and test books. To her, "how to teach depends on the nature of the subject and where I am in the annual plan". (Turkish version: *nasıl öğreteceğim konuya ve yıllık planda nerede olduğuma bağlı olarak değişir*).

She explained her views about students' attitudes toward mathematics as: "I am the teacher of grades 6, 7 and 8. Although I am not at the high school, I think that it is late to prevent the occurrence of phobia of mathematics because I am having difficulty teaching 6^{th} graders. Last year I encountered mathematics phobia even at grades 4 and 5. We, as a nation, perceive mathematics as if it was a monster and we

spread this perception very widely". (Turkish version: *Ben 6, 7, 8 öğretmeniyim, lisede değilim ama matematik fobisinin oluşmamasında geç kalındığını düşünüyorum. Çünkü öğretmenlikte en çok uğraştığım şey 6. sınıflarda hatta geçen sene girdiğim 4,5 sınıflarda bile matematik fobisi vardı. Bizim ulusça böyle kendi kendimize yaydığımız öcüleştirdiğimiz bir matematik var*). To her, learning mathematics starts in the family and parents can show students that they use mathematics in their life, as her mother did. She explained that due to her mathematics phobia and negative attitude, her mother wanted her child to like mathematics and to be able to do this, she sew pillows in rectangular, circular, triangular and square shapes or while going to market, she explained that they were using mathematics while giving and taking money. According to her, people make students afraid of mathematics and explained this by stating that "you are taking a school report, and then people say '*Never mind the other lessons. Tell us your mathematics score* although it does not have any meaning at grade 1. When you talk like that, the children think that it is the most important and difficult lesson and reject learning it and when they fail, they think that they cannot succeed in mathematics and they will be a useless person in the future. In other words, we are putting a kind of social pressure over them". (Turkish version: *Bir karne alıyorsunuz. 'Onları boş ver matematiğin kaç?' dediğiniz anda birinci sınıftaki çocuğun matematiğinden ne olur notundan ne olur ama onu söylediğiniz anda çocuk ha matematik bir adım geri çekiliyor ya da yapamadığı anda ben yapamıyorum, benden bir şey olmaz diye. Biz mahalle baskısını kuruyoruz çocuğun üzerinde*). She further added: "We can overcome mathematics phobia in grades 4 and 5 but in grade 8, this is much confirmed and difficult to overcome. Even when students realize that they like mathematics, they say 'I like doing mathematics with you but I do not like mathematics as a subject,' or 'I like mathematics of grade 7 or 8' or I like the teacher, not mathematics". (Turkish version: *4, 5 sınıflarda matematik fobisini daha yenebilirken 8. Sınıfa geldiğinde daha kemikleşmiş oluyor. Hani beni sevip matematiği sevmeye başlasalar bile bunu sadece bana özdeşleştiriyorlar. Öğretmenim sizi seviyorum, sizin ile matematik yapmayı seviyorum ama matematiği sevmiyorum. Kafasında matematik sevilmez fikri o kadar kemikleşmiş ki sevdiğini fark ettiğinde bile ya ben matematik sevmiyorum ama Esra öğretmen ile matematik*

yapmayı seviyorum diyor. Ya da ne bileyim 8.sınıf, 7. sınıf matematiğini seviyorum diyor).

Views about mathematics curriculum

She is happy with the latest mathematics curriculum. According to her, adding fractals to grade 8 curriculum and snap cubes to grade 7 is helpful for improving spatial ability of students. According to her, "even though there are new subjects added, curriculum is more moderate compared to previous years." (Turkish version: *müfredatın geçen senelere göre hafiflediği bir gerçek yeni eklenen konular olmasına rağmen*). She was unhappy with unit of "sets" in grade 6 as students start this unit suddenly after enrolling in 6^{th} grade. Moreover, she thinks that the order of algebra and real numbers should be revised as students solve first degree equations without knowing the real numbers (negative numbers).

While explaining the benefits of the current mathematics curriculum, she also said: "I think it makes mathematics a bit more sympathetic. They see mathematics is more useful than they once thought. I think they integrate mathematics in their life. Previous mathematics was only on the board but now it is a lesson which they can face in their daily life."(Turkish version: *Matematiği biraz daha sevecen hale getirdiğini düşünüyorum. Matematiğin daha faydalı bir şey olduğunu görüyorlar. Matematiği daha yaşamın içine kattıkları düşünüyorum. Önceki tahtada kalan bir matematikti. Bunda biraz daha hayatın içinde, günlük yaşamda karşılarına çıkan bir matematik.*)

According to her, with this mathematics curriculum teachers have started to use different teaching techniques other than direct teaching and they can find several materials either on web sites of MoNE or different sites. To her, course books and workbooks have become more enjoyable. She said that "….if we consider the books as manipulatives…. During our university education, I remember that I compared our books with the foreign books and I liked the latter very much. Now our books are like them. Children find these books entertaining and they started to like them. Methods of teaching the subjects, annual plans, and question styles in the work books are much more enjoyable. They have become much easier to understand". (Turkish

version: *kitabı da bir materyal olarak düşünürsek biz üniversitede okurken hatırlıyorum ben bizim kitaplar ile yabancı kitapları karşılaştırır ne kadar güzel kitaplar derdik…. Şimdi artık bizim kitaplarımızda öyle. Çocuklar daha eğlenceli olarak bakıyorlar kitapları da sevmeye başladılar. Konuların işleniş tarzı yıllık planlar konuların işleniş tarzı ders ve çalışma kitaplarındaki soru tipleri hepsi çok daha neşeli çocukların daha kolay anlayacağı seveceği hale geldi bence).”*

She is of the idea that parents are not aware of the changes in the mathematics curriculum and noted: “They do not have an idea about these; they only know that books have been changed and now there are more activities than before but they cannot compare the old and the new system”. (Turkish version: *Çok fazla fikir sahibi değiller. Sadece kitapların değiştiğini biliyorlar, biraz daha fazla etkinlik olduğunu ama genel olarak eski ile yeniyi karşılaştıramıyorlar*).

The Participant: Burcu

Views about mathematics

She explained her views regarding mathematics as: “Mathematics means a lot to me. It’s my life and everything that I deal with. It is not a single thing. The mathematics curriculum of elementary school is different and that of high school is completely different. They are different mathematics but they mean lots of things and they are important parts of life”. (Turkish version: *çok şey ifade ediyor tabi şu anda benim hayatım şu anda uğraştığım şeyler ama tek bir parça değil tabi ki ortaokul müfredatı ayrı lise müfredatı apayrı, ayrı ayrı matematikler çok şey ifade ediyor ama ayrı ayrı yerlerde tabi hayatın önemli bir parçası*). She is aware of the fact that mathematics is everywhere in life and she never failed to find the connection between real life and mathematics but now she realized that students have problems with finding it.

Views about teaching and learning mathematics

While talking about her undergraduate years, and her experience as a student, she referred to the education system as traditional. She stated that the system was

totally different so she would not like to compare the present system with the old one. The old system was based on too much input and expected the learners to come up with the same amount of the output in a very short time. However, now, the input or information is divided and not presented at once. Based on her previous experience as a student, the approach was not appropriate and she added that "incorporating that old style as it was into her teaching would be misleading and futile. We should adapt to system". (Turkish version: *deneyimimiz hatıramız doğrusu kullanmak istersek o yanlış olur sisteme adapte olmak lazım*).

In addition, she thinks that if her success or failure as a student was due to these experiences, she can be more of a help for her students and understand and help them better. She further added, "If I had been unsuccessful at math, it would be more of a helpful experience for me as a teacher now; I could understand the feelings of the unsuccessful ones and put myself in their shoes". (Turkish version: *Matematik yapamayan bir çocuk olsaydım bu benim öğretmen olarak daha çok işime yarardı. anlayamayan öğrencinin ne hissettiğini kendi tecrübemden daha rahat anlardım, empati kurabilirdim*).

In her opinion, students do not need to learn math to a certain level during their education, but due to the curriculum, they have to.

She explained different learning styles and added that each student has an individual way of learning things. At secondary school level, she and her colleagues use inductive approach, but she stresses that when it is overdone, then it is not helping the students. Some students would rather see the whole picture rather than the parts of it. Some prefer images or icons as mental pictures, while others would like to link a new topic with a previous knowledge and compare them. She also stated that as teachers, they present the rules and leave it up to the students to find their own way around it to manipulate the input.

While explaining her teaching style and her role as a teacher, she put forth that if she were to compare the high school and the secondary school teachers, she would say that the former just lectures and covers the topics as most students themselves are either willing to learn or not and she is not concerned much about if the students are doing fine or not because the students at high school level are

capable of distinguishing why they are doing fine or why they are behind the class. That is, they can attribute the reasons somehow to themselves, the content or the teacher's style; thus, they are more attentive in lessons. If they are not, they do not disturb their classmates. However, the latter, the students at secondary school, are a little more attached to the teacher emotionally and the teacher's any sort of attitude. Her teaching style, her dressing style, and even her football team may become an important element for the students to like or to dislike her and of course the lesson. They are not yet capable of concentrating on the lesson or the success

She explained her role as a lecturer as: "I have to lecture for a while and that way the students can learn, not with games all the time."(Turkish version: "*Daha çok anlatan çünkü dersin içerisinde belli şeyleri kazandırmak zorundayız, belli kuralları… Her şeyi de oyun oynayarak öğrenemezler*). She further added that "it is not totally traditional lecture style, but the lesson-math- is not much suitable for a student-centered approach. They have to learn step by step and at that time the teacher is inevitably the input provider and is in charge of teaching the information and the students participate by asking questions." (Turkish version: *Dediğim gibi tamamen klasik eski mantık değil. Matematik dersi öğrenicinin katılımına çok uygun değil. Öğrencinin belli bir sıraya göre öğrenmesi lazım. Mecburen orada yöneten ve bilgiyi veren siz oluyorsunuz. Öğrenciyi de ufak tefek katıyorsunuz, soru cevap şeklinde*).

She also mentioned that she does not even remember how many times she has covered the same topics in 4-5 years and how many questions or problems she and her students have solved together. Thus she indicated that she is experienced enough to adapt to topics and to link some certain topics with each other unless there is a major change in the curriculum. She and her colleagues share ideas about teaching topics if she is going to teach one topic for the first time. She also takes some notes about the topic to be covered in class, so she is prepared and makes sure that she uses correct sentences in class and the students copy them correctly.

She thinks that the students' positive or negative attitude toward math is highly related with their relationship with the teacher. However, students sometimes may like the teacher and have a good communication with her; but still, they may not

like the course. This is not likely to happen at high school because whether they like the teacher or not, they have to learn math, so in a way they kind of have to like the course.

Views about mathematics curriculum

She stated that she was well aware of the fact that some amendments could be made to the current mathematics curriculum and it could work just fine. She also added that she knows that education is a process and the authorities are trying to develop the system, and so time is needed to see if the new things will work out well or not. She thinks that adaptation is much easier for novice teachers and young generation of teachers as they are open to it. She gives examples from her own life and puts forth that she was taught inductively and poor students were cared about. That is, it was important for the teacher to make sure that the poor ones were doing fine as the good ones were already good, which she thinks an American style or approach. Thus, as she has such an experience and has been trained in how to care for the needs of the students, it is easy for her.

Regarding the mathematics curriculum change, she stated that "changing the whole mathematics curriculum could pose problems on the part of the students and teachers. Changes should not be abrupt as they may be fruitful in the long run but may cause problems for the first couple of years." (Turkish version: *Müfredatın birden değişmesi, öğrencinin adapte olması, öğretmenin adapte olması sıkıntılı şeyler. Hep süreç işi. Birdenbire değişim her zaman ilk senesinde, ikinci senesinde tam istenilen verimi, randımanı vermemiş olabilir. Zaman geçtikçe aynı istikrarla ne bekleniyorsa artık o beklenmeye devam ederse, biraz daha taşlar yerine oturacaktır. Ben öyle düşünüyorum*).

She explained the difference between the old and the new mathematics curricula. She stated that when students failed in math in the past, it was attributed to the students' inability. However, now each and every student is targeted and it is important to be able to teach them all. To do that, they use the inductive method, shapes and such kind of images that will attract the students' attention.

She noted that she did not do the activities in the teachers' book as they were just a waste of time, but the students were free to do them on their own. In addition, to her, students can be confused while doing such an activity and the teacher may fall behind the curriculum. While explaining the factors affecting the use of manipulatives, she mentioned grade level and class size and stated that as the class gets crowded, she does not ask the students to do the activity but she just exemplifies it herself, but if the size is small, then the activity becomes more feasible.

The Participant: Ahmet

He learned how to use materials in teaching mathematics, designing materials and computer aided mathematic instruction during his undergraduate years. Regarding the education received in undergraduate years, he said, "During my undergraduate years, we designed our own materials especially for the 7^{th} and 8^{th} graders. However, whether all those things would work in class or not was not clear to many of us at the time. One interesting aspect to it was that some of my classmates were designing those materials for the sake of designing them. Thus, I think the materials should be piloted and feedback is needed to see if they are fruitful or not. Then I will feel safe to employ them in class." (Turkish version: *Üniversitede biz materyalleri kendimiz tasarlıyorduk. Ne olabilir bu konu hakkında (diye) ama kazanımlar 7. sınıf 8. düzeyine aitti. Fakat yaptıklarımız gerçekten işe yarar mı çocukların görmesini gerçekten kolaylaştırır mı, zorlaştırır mı, bu konuda gerek var mı gibi soru işaretlerimiz vardı. Bazı arkadaşlar da sadece materyal hazırlamış olmak için hazırlıyorlardı. Konular belirlenip kabul görmüş materyaller kullanılırsa çok daha iyi olur*). He added: "If I could implement what I was trained for at the undergraduate level, things would be different now. There I learned the actual thing but testing to see its effectiveness was kind of hard due to lack of a class. I mean I am not sure to what extent the student-teaching practice was effective. I only lectured during the semester and it was for a limited amount of time. We had to arrange the class hours as we were a group of student-teachers at a school so we could have a chance to do practice teaching once a week or once or twice a month. However, if we had the opportunity to implement what we were taught and how we should teach, it

would have been more fruitful. Now, after I start teaching, I find myself uncomfortable to try an activity that I designed at that time but did not have a chance to implement it and get feedback doing my practice teaching. After starting professional life, I felt uncomfortable trying to figure out whether they are applicable or not or how I can make students understand the subjects better, or whether I can solve such question types, or whether I will have enough time to do them etc. And these all distress me." (Turkish version: *Üniversitede gördüklerimin hepsini uygulasaydım daha farklı olurdu. Orada kısmen işin içindesiniz ama birebir öğrenci ile uygulama imkânı bulamıyorsunuz. Bize verilen staj ne kadar yeterliydi? Ben bir dönem boyunca sadece ders anlattım bunu da belli aralıklarla anlattık. Grupça gittiğimiz için ders saatlerini ona göre ayarladık haftada bir gün ayda bir veya iki gün. Orada bunu yaparken ona hazırlanıyorsunuz ama üniversitede aldığınız o eğitimleri mesela hemen akabinde uygulasanız yapsanız çok daha rahat belki uygulayacaksınız, kullanmaya başlayacaksınız ama şu anda meslek hayatına geçtiğiniz zaman acaba nasıl olur bunu uygulayabilir miyim nasıl daha mı iyi anlarlar şu soru tipini çözebilir miyim o zaman buna vakit kalır mı gibi sorulara cevap arıyorsunuz. Sıkıntı oluyor*).

Views about mathematics

According to him, mathematics is the basis of all sciences and it is being used in physics, chemistry, and biology and in fact it is referred to in almost all sciences, and it's mostly abstract for students.

Views about teaching and learning mathematics

He explained his past experiences of learning mathematics as follows: "I started liking math at high school. We were 20 students in class and our teacher was a sincere person and thanks to him, I loved math. He would simplify the subject and even when the math problems were difficult, he would help us understand the logic behind every question and guide us to come up with ways to solve them rather than make us memorize some ways of solving problems."(Turkish version: *Matematiği lisede sevmeye başladım.Lisede sınıfımız 20 kişilikti. Matematik öğretmenimiz gayet*

samimiydi. Matematiği bana sevdiren o oldu. Dersi gayet basite indirgeyerek anlatıyordu. Problemler zor olmasına rağmen mantığını vererek ve ezberden uzak bir şekilde mantığını sevdirerek anlatıyordu. Matematikte formül ezberlemek yerine bunun ile alakalı şu buradan aklınıza gelebilir deyip alternatifler üreterek anlattırdı). He summarized the effects of his past experiences on his teaching in his own words as: "All these have definitely contributed to my teaching. In fact, I had a good my math teacher. He taught me the rationale behind mathematical, so I am able to guide my students now. Also, I had another teacher after high school and he was good too, so I'm trying to be like them and I am trying to use concrete materials in teaching."(Turkish version: *Bu deneyimlerim öğretmenlik hayatımı kesinlikle etkiledi. Mesela iyi matematik öğretmenim bana matematiğin temelden nereden geldiğini kavratarak öğretmişti.. Aynı zamanda liseden sonra bir matematik öğretmenim vardı o da çok iyiydi.. Ben de mümkün mertebe o şekilde yapmaya çalışıyorum. Bunları daha çok somut materyal kullanarak yapmaya çalışıyorum)*.

He considers that when materials –either visual or 3D ─are used, you as a teacher are at an advantage first of all. He explained how students learn mathematics saying "when the students study hands-on, they learn a lot better. Also, when the teacher writes a problem on the board and the students want to come up to the board and solve it, their self-confidence is boosted and they become more motivated to learn. Students have different learning styles based on their level. A 6^{th} grader is more of a child but when he becomes an 8^{th} grader he is more mature. Therefore, I change my teaching style taking these factors into consideration. For example, I use more materials with the 6^{th} graders and I try to employ more visuals. I doubt their effectiveness, though. However, while teaching 8^{th} graders, I try to do it through solving different kinds of problems." (Turkish version: *Öğrenci kendi yaptığı zaman daha çok öğreniyor. Tutup tahtaya bir örnek yazdığınız zaman 'Öğretmenim ben yapayım' dediği anda kendine güveni geliyor. Dolayısıyla daha bir öğrenme isteği doğuyor. Öğrencilerin öğrenme şekilleri sınıf düzeyine göre farklılık gösteriyor. 6'daki bir öğrenci birinci kademeden yeni mezun olmuş. Daha yeni ikinci kademeye başlamış. Çocuksu bir tarzı var ama 8'e girdiğinde bambaşka. Artık yetişkin bir tarzları var. Onlara ders anlattığım metot ile 6'lara anlattığım metot birbirinden farklı. 6'lara daha çok materyal kullanıyorum, daha çok görselleştirmeye*

çalışıyorum. Bunu ne kadar yaptığımız tartışılır ama 8'de bunu yaparken daha çok soru üzerinden, soru çeşitleri üzerinden konuyu öğretmeye çalışıyorum). He believes that there are different intelligences; some are auditory and some are visual, so if we, as teachers, design activities taking these into consideration, I would say we will be 60 % successful in teaching math.

As for the factors affecting the teaching style he noted: "if I plan to do an activity in class, I check if the students have the necessary materials or equipment with them as this is important. Then, as a teacher I make sure if I am familiar with the technique needed for that specific activity to facilitate teaching and learning, and I also need to have a well-prepared plan to avoid any confusion on the part of the students." (Turkish version: *Birincisi etkinlik yapacaksam öğrencilerin materyal getirip getirmediği etkiliyor. İkincisi o teknikle alakalı ciddi bilgiye sahip olup olmamam, tekniği nereye kadar götürüp götüremediğim. Yani kullanacağım tekniğe tam olarak hâkim olmalıyım. Hem öğretmen boyutunu hem öğrenci boyutunu çok iyi planlamam lazım ki öğrencide bir kavram yanılgısına sebep olmayayım*).

Views about mathematics curriculum

Regarding the mathematics curriculum he stated that "The curriculum has been renovated since 2005, but I wonder how much of it has actually been implemented. I do not think it is being implemented at all. We are still in a transition phase and that will take some time." (Turkish version: *2005 ten beri müfredat değişti tamam ama ne zamandan beri gerçekten uygulanıyor? Hala uygulanmıyor yani hala geçiş aşamasındayız. Buda zaman alacak bir süreç*). He further added: "I am not much happy about the teachers' book sent by the Ministry of Education. Unfortunately, the time allocated for the activities and that of the teaching of the content are not equal. For example, class hour for fractions is determined as 4 hours but if I want to do the activities suggested there, it is impossible to cover them all in 4 hours." (Turkish version: *MEB öğretmen kılavuzu ile benim sıkıntılarım var. Maalesef etkinliklere verilen süre ile ders saati süresi birbirlerine uymuyor. Diyelim ki kesirlere 4 saat vermiş ama oradaki etkinlikleri yaptırırsak bu saati geçecektir)*.

He considered SBS as an obstacle for the implementation of the curriculum and said that "Parents and the students make it their priority and as a teacher I feel obliged to solve many questions rather than teach the content. The concepts and the core are not that important in that case. There are no plans about the future and there is a terrible misconception about it. I think this is all related to our examination system and different attitudes." (Turkish version: *Çocuklar ve ailelerin beklentisi tamamen sınava odaklı. SBS'den dolayı soru odaklı gidiyorsunuz. Kavramsal öğrenmeye bakılmıyor. Bu da anı kurtarmak gibi oluyor. Geleceğe dair plan yapılmıyor. Bunun ile alakalı ciddi bir yanılgı var. Bu da sınav sisteminden kaynaklanıyor. Değişik tutumlarla alakalı*). He added: "Placement test (SBS) is redundant and highly unnecessary I think. Also the materials or books available in the market for the exam are not good enough because the mathematics curriculum has been changing since 2005 and there are still some amendments made to the mathematics curriculum but those books are not updated. They fall behind the new mathematics curriculum. Therefore, the students focus on the exam rather than the content and try to memorize certain question types without internalizing math, which challenges us seriously." (Turkish version: *Seviye Belirleme Sınavı bence çok gereksiz bir uygulama. Bunun ile alakalı piyasadaki kaynaklar aslında çok sıkıntılı çünkü matematik müfredatı yaklaşık 2005'ten beri değişiyor ve bunu da kaynaklar iyi takip edemiyor. Dolayısıyla öğrenci sadece SBS' ye odaklanıyor. Matematik öğrenmektense soru kalıpları, soru tiplerini öğrenmeye gidiyor. Bu da ciddi anlamda bizi zorluyor*). To him, it is fortunate that 6th and 7th graders will not take this exam and they do not have to be evaluated according to it.

However, he emphasized that not having exams in the education system does not affect the teacher to a great extent. He stated this by saying "I do not think that the exam system affects the teacher much. I think even if there is no exam, there will still be preparatory courses, so there will be problems. The students will have to go to these courses and deal with lots of questions and exams. When they get a low grade on those exams, the parents will complain that their kids do not understand math even though those kids get high grades at school. Even if the exam is abolished, it will take at least 5 or 6 years to settle things down. And the parents should be educated or informed about the process and changes." (Turkish version: *Bence sınav*

sisteminin olması öğretmeni çok etkilemiyor. Sınav olmasa da dershaneler olduğu için sorun var. Yine çocuk dershaneye gidecek ve dershanede farklı sorular çözülecek ve denemeler olacak. Denemelerde öğrenci düşük aldığında veli benim çocuğum matematik bilmiyor diyecek. Derste yapılan sınavda yüksek not alması bir anlam ifade etmeyecek. Dolayısıyla sınav sistemi kalksa bile müfredatın bu şekilde uygulanması zaman alacak bir süreç. En az 5, 6 yılın geçmesi gerekir. Velilerin de bu süreçte bilgilendirilmesi gerekir).

Relevant to this, he further stated that "It is significant that teachers accept the new system, which encourages students to do hands-on activities and they learn better that way. That approach should be accepted and teachers' perspective should be altered in this sense. If the teacher believes in the use and effectiveness of materials, she or he will apply them in class and allocate time for them even if the system is different." (Turkish version: *Öğretmenlerin sistemin değiştiğini kabullenmesi yani yaparak, yaşayarak öğrenmenin ön planda olduğunu mutlaka kabullenmesi gerekiyor. Yani öğretmenin görüşünü değiştirmek lazım. Öğretmen materyallerin yararlı olacağına inanıyorsa müfredat bunu gerektirse de gerektirmese de bir şekilde yer bulur ve yapar. Sistem farklı da olsa bunu yapar*.)

4.2. Upper Elementary mathematics teachers' views about the use of manipulatives in teaching mathematics

To understand the teachers' views about use of manipulatives the researcher analyzed both the responses of participant teachers' to questions of interviews made before the training and after the application and field notes had taken during the attendance in school together with the students' notebook, lesson plans, annual plans. In the following section the analysis will be presented under subsections in order better understand the participant teachers' views about use of manipulatives.

4.2.1. What manipulative material means

All of them expressed that manipulative materials make mathematics concrete to students but have different ideas about what constitute manipulative materials. To

Alkın and Ahmet the important characteristic of manipulatives is making mathematics seeable and touchable to students. Alkın defined manipulatives as "I think that they are materials made by students with their own hands or given to them as ready-made. Students can learn mathematics by themselves by using cartoons, scissors. Or we can give them cubic prisma and show them edge and sides thus they can discover it by touching and seeing."(Turkish version: *Çocuğun kendi el becerileriyle yaptığı yada eline hazır olarak verilen materyal olarak düşünüyorum. Kartonlar makaslar kullanarak çocuk o matematiği kendisi de kesip biçerek yapabilir.yada biz eline küp prizma vererek işte prizmanın ayrıtları üst tabanı yan tabanı diyebiliriz çocuk dokunarak görerek keşfeder*." However, to Esra the main issue is making mathematics concrete to students and one can do this by just giving an example and by showing the real life connection this example is a manipulative in terms of making mathematics concrete to students. She explained this view point of her as follow: "first of all, the tangible items like cubes, pattern blocks, algebra tiles or geoboard but here I think originally, when we set a pattern, as I said before, since we show to the students their functions in the real life we are making the mathematics more concrete even if it is very abstract" (Turkish version: *ilk olarak elle tutulur gözle görülür küpler (cubes) örüntü blokları (pattern blocks) cebirsel bloklar (algebra tiles) yada geometri tahtası (geoboard) gibi şeyler ama ben burada biraz daha orijinal düşünüyorum demin dediğim gibi örneklendirdiğimizde de onu günlük yaşama kattığımız için o fikri matematik bilgisini somutlaştırmış oluyorsunuz o anda elle tutulamıyor olsa da somutlaştırmış oluyorsunuz*). To Burcu, textbook, notebooks, test books, and study sheets are kind of manipulatives but toys are not. Different to Burcu, for Ahmet manipulatives are materials specially designed for teaching mathematics and can be 3 dimensional objects.

Alkın, Esra and Ahmet were aware of the materials in the school and in the teachers' book. However, Burcu neither aware of the materials in the school nor in the teachers' book.

4.2.2. Experience in use of manipulatives

All of them in somehow had an experience with manipulatives. They all were familiar with abacus, beans, and sticks from their primary years. They all expressed the "volume sets" for teaching volume and area relation of prism. But knowing manipulatives and having experience in use of manipulatives was different from each other. In terms of using of manipulatives in teaching mathematics Alkın had no such kind of experience except modeling fractions by cutting papers. Therefore, she wanted to learn how to use materials in teaching mathematics. Burcu had little experience. She mentioned that she used volume set while teaching volume and area relation of prism. With the help of this activity, students easily understood the topic. However, they could not do so before over the formula although she spent a lot of effort in trying to explain the formula. In addition while explaining the situation of line with plane she did lots of things in the class but after showing the relation by bringing paper, needle and yarn, students understood the subject. However, Ahmet had moderate experience in use of manipulatives in teaching mathematics as during his undergraduate education he had taken lessons on designing materials and use of materials in teaching mathematics. As for his experience in using manipulatives, he stated that he use fraction bars for multiplication of fractions and explained how he used them as "I used both the OHT (over head projector) and smart board. I divided a rectangle into some parts and I brought another one and divided it into the same parts so by that I could show the multiplication. I distributed the over head transparencies to the students and asked them to the same by using those transparencies. They liked it and I think it was effective. They understood that when math is presented with concrete objects, it is not abstract any more, and they will like it." (Turkish version: *hem asetat üzerinde yaptım hem de akıllı tahtada yaptım belli bir dikdörtgeni eşit parçalara böldüm sonra aynı boyutta dikdörtgeni getirip eş parçaya böldüğümde koyduğum zaman taranan parçalar çarpma etkinliğini gösterdi. onlara asetatları dağıttım sonrasında ve de kağıttan yapmalarını istedim. Çok da verimli oldu hoşlarına gitti. Gördüler çünkü matematik doğası gereği soyut olduğu için bu şekilde somut aletlerle örneklendirmek görselleştirmek onların hoşuna gidiyor*).

Esra is the one who had much experience in use of manipulatives both in university education and real class application as a teacher. In her previous school, she was teacher of grade 4 and 5 and used lots of materials while teaching mathematics due to the request of school administration. She used symmetry mirror, pattern blocks, geoboards and solid materials while teaching different topics. She used pattern blocks in group work, students made different shapes and later found symmetry line of shape and enjoyed so much. Like pattern blocks, she also used symmetry mirror in group work and asked students to create rectangle, parallelogram by using symmetry mirror and shape of square. In addition, she together with the students prepared transparent fraction bars and used them while learning fractions. But she did not use any manipulatives in the observed school and she stated that "actually I can use fraction bars in grade 6 but I did not use them and even didn't remember that I have used them previously". (Turkish version: *Aslında kesir kartlarını 6larda yapabilirdim. Neden yapmak aklıma gelmedi acaba?*)

The researcher clarified not use of manipulatives in teaching mathematics by observing the class, bulletin board in class, daily plan and students' notebook as there was no evidence for the use of manipulatives except modeling of fractions in grade 6. Moreover, the researcher asked teacher of grade 7^{th} (Alkın and Burcu), whether they used paper folding activity in grade 7 while explaining angle bisector, median or not. Besides the fact that this activity is in the lesson book, they stated that they did not do paper folding activity. In addition, although decimal numbers explained via base-ten blocks in the unit plan, they did not use models of base-ten blocks while teaching.

4.2.3. Views about use of manipulatives

Although all the participants advocated the use of manipulatives in teaching mathematics and considered that use of manipulatives makes mathematics concrete for students, they had different view points regarding the benefits of these materials to students. But all of them were in the opinion that not all students benefit from the use of manipulatives as there are different intelligence types and learning styles.

Alkın considered that use of manipulatives allows the students to practice all kind of memory and enhance the power of learning as students do not learn just by

listening and writing some students learn by seeing ,touching or moving. To her, manipulatives should be used in teaching mathematics to enhance learning and improve the place of information in memory.

According to Esra, teachers absolutely should use manipulatives in lessons and explained this in her own words as "by doing this, we touch upon the logic of the operation and get rid of the habit of memorization. You know there is an expression: "If you just say something, I forget; if I see it, I remember it a bit; but if I do it, I duly remember. Since they are doing something, they remember better than before". (Turkish version: *şimdi biraz daha işin mantığına deyinmiş oluyoruz ezbercilikten de kurtulmuş oluyoruz…. konu çok daha akıllarında da kalmış oluyor. Vardır ya işte bana söylersen unuturum, görürsem biraz aklımda kalır, ama yaparsam hatırlarım gibi bir söz var. Onun gibi yaptıkları için, kendileri uğraştıkları için daha akıllarında kalıyor*"). She mentioned the results of the study about the effects of the use of manipulatives on student's learning done in her previous school which revealed that manipulatives have a very big influence on the learning procedure however they are used. However, she considered that although manipulatives are very important, if they remain as materials used in the school and they are not connected with real life, students will not be able to know their role in the real life even if they are very concrete. She further said that "students are not able to transform the knowledge learnt through the use of manipulatives when solving a problem; therefore, I should reinforce the knowledge by solving problems". (Turkish version: *çocuk öğrendiği bilgileri (somut materyalle) karşısına başka bir yerde soru çıktığında dönüştüremiyor ve onu soru çözerek pekiştirmem gerekiyor)*. In addition, to her not all students like using manipulatives and the majority of them do not like these items and consider them as an unnecessary, a burden and a boring job or they may be pleasant with the use of these items but they do not connect their relations with the subject. She felt herself competent about knowledge of manipulatives and does not think that there is a problem for connection of concrete and abstract as she does not teach high level mathematics.

Contrast to her thoughts that teachers should absolutely use manipulatives in teaching mathematics and by using them we can touch upon the logic behind the

subjects and overcome the habit of recitation; she considered that using manipulatives is not a necessity for learning and teaching mathematics.

Burcu believed that manipulatives can be used if there is a need. But to her, they are helpful. She also stressed that the nature of the lesson does not lend itself to some games or hands-on activities like in English classes. She used the terms “toys” and “games” while explaining her thoughts about manipulatives. She thinks that the materials are limited in that sense, and some shapes or videos could be helpful in a math class. She added that there are not many activities suggested in the teacher’s book, either. She further added that except for the teacher’s book and pencil, paper and tangrams, there are no manipulatives; she did not see any of those at the observed school either.

According to Ahmet, concrete materials enable students grasp math topics better and it is more effective than memorized formulas so they do not forget what they been taught. For example, 3D objects make it easier to exemplify volume and area and when comparing the area of a cylinder to that of a cone, it easier to show that it is 1/3. The students love it and they get to see that math is not just some formulas and they can apply the knowledge to see what it is like. He is definitely of the opinion that concrete materials are to be used in the teaching of mathematics, they should be developed specifically for each topic or subject and the teachers are needed to be trained in that as well. He summarized his view point on this issue as follow: “In-service training is a must, I guess, and all math teachers should attend to it. We should get rid of the old traditional way of doing things. By that I mean solving problems with pen and paper, and that is it. Math can now be taught by the use of 3D objects and the curriculum lends itself to it now as it is constructive, so materials are indispensible parts of the course. However sometimes being trained in the use of or incorporation of materials into the course may not give out the expected results. I watched the movie *The Last Samurai* There the guy was trying to use and benefit from all the guns at first but later he resorted to the traditional sword. On the sort, ‘the warrior who can integrate the old and the new methods’ was engraved. I guess any teacher should be like that, I mean, there must be combination of old and new methods and it should be eclectic because at times one subject can very well be taught with no extra materials but just pen and paper. Well, if that is the case, why

would you bother involving some materials?" (Turkish version: *hizmet içi eğitim olmalı tüm matematik öğretmenleri buna katılmalı şu zihniyet artık kalkmalı matematik artık kalem kağıt ile öğretilir sadece soyut bilgilerden ibarettir. Matematik artık 3 boyutlu cisimlerle öğretilebilir çünkü müfredat artık yapılandırmacı bir yaklaşım izlediği için materyalde artık vazgeçilmez bu eğitim düzenli ve uygulamalı olmalı. Şöyle bir film izlemiştim son samuray diye orada ilk başta adam bütün silahları kullanmaya çalışıyor sonunda kılıç kullanıyor kılıcın üstünde bir yazı vardı "kendinde eski ve yeni yöntemleri birleştiren savaşçı diye" bence bir öğretmende böyle olmalı yani ne tamamen eski yöntemlerden kopuk nede tamamen yeni yöntemlerle bürünmüş değil ikisini de harmanlayıp kendine göre bir sistem üretmeli. Yani bir konuyu kendi belirlediği farklı bir yöntemle materyal kullanmadan çok daha rahat kavratabileceğini söylüyorsa iddia ediyorsa o öğretmen illa materyal kullanmalıdır diye bir şey söyleyemeyiz.*)

4.2.4. Factors effecting decision of use or not use of manipulatives

To identify factors the teachers consider in deciding to use or not to use manipulatives in teaching mathematics the researcher asked specific questions to participants during the interview before the training and presence in the school. It was revealed that during the interviews the participants especially Esra and Ahmet stated factors which have minor affect on decision of use or not use manipulatives but after application in real class environment and talks with the researcher during the presence at school they have stated the real reasons which prevented them to use manipulatives.

According to Esra, use of manipulatives becomes more important for the students at lower grade levels. She mentioned grades 4, 5 and even 6 for the use of manipulatives and stated that "they are needed at grade 6, but at grade 8 even if they are entertaining the students think themselves as adults and they see these items like toys, therefore, they tend to disdain the manipulatives". (Turkish version: *6 larda da daha ihtiyaç oluyor ama 8 lerde gerçi eğlenselerde serde bir ergenlik büyüdük biz bunlar oyuncak gibi kalıyor eğlenmelerine rağmen aman hocam ne bu diyebiliyorlar*). Similar to Esra Ahmet had opinion that a 6th grader is more of a child

but when he becomes 8th grader he is more mature, therefore, he uses more materials with the 6th graders and tries to employ more visuals. However, while teaching to 8th graders, he tries to exemplify different problems and the ways to solve them Thus according to Esra and Ahmet, view point of students and grade level affect teachers while deciding use or not use of manipulatives in teaching mathematics. To Burcu, grade level is important for deciding to use or not to use manipulatives. In addition, existence of specific manipulatives for specific subjects or topics is important for Esra and Ahmet. Namely, subject to be taught is important while deciding use or not use of manipulatives. Moreover for all of them time is important while using manipulatives. It is important for Alkın, since she wants to do everything that she has planned including lesson plans, lesson book, handouts and test papers and solve a lot of questions. Alkın, Ahmet and Esra considered that doing activity takes more time and Esra stated the reason not using manipulatives in the observed school other than school administration as "this year it is a bit related with the time. I could not catch the time because of successive holidays or any other tasks therefore I remained behind the schedule. Therefore I postponed the use of them. Any other reason is that I am planning a 10-minute activity but since the children see the manipulatives like toys it takes almost 1-lesson hour. I can say that my biggest handicap for not using manipulatives is the "time"". (Turkish version: *Bu sene biraz zaman ile ilgili zamanı yetiştiremedim peşpeşe tatiller okulla ilgili başka şeyler olunca o yüzden zamanın gerisinde kaldığım için yapmadım genel olarak zamandan dolayı ben materyal kullanımını erteleşmiş oluyorum çünkü çocuklar ne kadarda olsa onu oyuncak gözüyle gördükleri için 10 dakikalık bir etkinlik planlıyorsunuz o 10 dakikada asla bitmiyor bir ders saatini illaki alıyor. O yüzden benim materyal kullanamamamdaki en büyük handikabım ne diyelim zaman*).

According to Esra and Burcu, school administration has influence on the use of manipulatives if they request teachers to use then teacher should use them. Esra summarized this effect in her own words as " of course school administration has influence, my previous school was laying much more stress on the use of them and stated that you should make activities on each subject but here there is no such tendency, therefore it is very much connected with the attitude of the administration". (Turkish version: *kesinlikle okul yönetiminin etkisi oluyor diğer okul*

material kullanımına çok fazla önem veriyordu ve her konuda veya derste sürekli etkinlik yapın diyordu burada böyle bir istek yok o yüzden okul yönetimi ile çok alakalı).

As explained in Chapter III, apart from interviews and observations the researcher took field notes during the stay at the school and according to 05.12.2012 dated field note, the participant Esra stated her view points about factors affecting to use of manipulatives as "viewpoint of the children to manipulatives – if they are not accustomed to them, they may like or they may consider as unnecessary. Level of the classroom – the students at elementary school likes much more than those at the medium level and therefore they are attending to these activities rather than others. It is easier to pick up if you are behind the curriculum at the elementary classrooms. It is different at medium level classrooms. Activities with manipulatives take much longer time because they could not make connection between the activity and problem solving and again you need to teach the lesson and solve problems". (Turkish version: *Çocukların materyale bakış açısı—alışmadıkları zaman çok hoşlarına da gidebilir veya gereksiz de diyebilir. Sınıf seviyesi--- küçük sınıflar daha keyifli yapıyorlar daha çok katılıyorlar. Küçük sınıflarda müfredatta geri kaldığınızda toparlamak daha kolay oluyor. Büyük sınıflarda bu farklı. Materyal zaman alan bir süreç. Çünkü çoçuklar o materyali kullandıktan sonra soruyla bağdaştıramıyorlar sizin gene dersi işlemeniz soru çözmeniz gerekiyor).* In addition, after application of four-pan balance on 23.12.2011 she mentioned that use of manipulatives decrease control of teachers over students. She summarized the effects of university education in use of manipulatives for teaching mathematics as follow: "Impact of university education: of course it affects but this is like raising a children, for instance, it does not matter how many books you read, your raising style resembles to method of your mother. Even though you studied it or you know that using manipulatives is very important since you did not experience it during your schooldays you do not tend to use them and you are doing a direct teaching and prefer less to use them. You know that using them is not a necessity; it is possible to learn the subjects without using them. In my opinion the most important reason is this, the others are just excuses. You can do material if does not available thus others can be overcome". (Turkish version: *Üniversite eğitiminin etkisi: oluyor ama bu*

tıpkı çocuk yetiştirirken ne kadar çok kitap okursanız okuyun çocuk yetiştirme şekliniz annenize benziyor. Siz ne kadar bunu görmüş olsanızda, materyal kullanımının yararlı olduğunu bilseniz de siz kullanmadığınız için eliniz gitmiyor ve direct teaching yapıyorsunuz daha az tercih ediyorsunuz. Onun zaruri olmadığını da biliyorsunuz o olmadan da öğrenilebiliryor. Bence en önemli neden bu diğerleri bahane materyalin yoksa da yapabilirsin diğerleri halladilebilri sorunlar). She even stated that "but teachers resemble to their teachers or their own studentship. Since we come from the recitation system, it is difficult to break this method but our students will become better teachers than we are". (Turkish version: *Ama öğretmen ne kadar olursa olsun kendi öğretmenine benziyor ya da öğrenciliğine. Biz ezberci sistemden geldiğimiz için bunu kırmamız zor olacak ama bizim öğrencilerimiz daha iyi öğretmenler olacaklar*).

Ahmet did not want to use manipulatives in teaching mathematics since he does not feel safe to use it. Other than that, he believes that the size of class or lack of materials can just be excuses for not using them (10.12.2011dated Field Note). Ahmet used base-ten-blocks on 12.12.2011 and after the application he mentioned the following items as factors effecting the use of manipulatives: classroom management, academic achievement level of students in terms of understanding the connection of abstract world of mathematics and manipulative; students should have intermediate level knowledge; time since little time left for writing and solving examples. In addition, after use of Four-Pan - Balance in the first week of January 2012 in grade 6^{th} he mentioned that a new perspective should be provided to the students so that they will get rid of the old traditional teacher lectures.

Different to Esra, Ahmet stated the following regarding the education taken in undergraduate years "During my undergraduate years, we designed our own materials especially for 7th and 8th graders. However, whether all those things would work in class or not was not clear to many of us at the time. One interesting aspect to it was that some of my classmates were designing those materials for the sake of designing them. Thus, I think the materials should be piloted and feedback is needed to see if they are fruitful or not. Then I will feel safe to employ them in class." (Turkish version: *üniversitede biz materyalleri kendimiz tasarlıyorduk ne olabilir bu konu hakkında ama kazanımlar 7. sınıf 8. düzeyine aitti. Fakat yaptıklarımız*

gerçekten işe yarar mı çocukların görmesini gerçekten kolaylaştırır mı, zorlaştırır mı, bu konuda gerek var mı gibi soru işaretlerimiz vardı. Bazı arkadaşlar da sadece materyal hazırlamış olmak için hazırlıyorlardı. Konular belirlenip kabul görmüş materyaller kullanılırsa çok daha iyi olur).

He further stated that "If I were allowed to implement what I have been trained for at the undergraduate level, things would be different now. There I learned the actual thing but testing to see its effectiveness was kind of hard due to lack of a class. I mean I am not sure to what degree was the student-teaching practice effective. I only lectured for a couple of times at one semester. We had to arrange the class hours as we were a group of student-teachers at a school so that we could all get a chance to do practice teaching. However, if we had the opportunity to implement what we were taught and how we should taught, it would have been more fruitful. Now, after I start teaching, I find myself uncomfortable to try an activity that I designed at that time but did not have a chance to implement it and get feedback doing my practice teaching. Now, I have to think about the class hours carefully and try to catch up the curriculum, which does not allow me be flexible and implement such activities." (Turkish version: *üniversitede gördüklerimin hepsini uygulasaydım daha farklı olurdu orada kısmen işin içindesiniz ama birebir öğrenci ile uygulama imkânı bulamıyorsunuz bize verilen staj ne kadar yeterliydi ben bir dönem boyunca sadece ders anlattım bunu da belli aralıklarla anlattık. grupça gittiğimiz için ders saatlerini ona göre ayarladık haftada bir gün ayda bir veya iki gün orada bunu yaparken ona hazırlanıyorsunuz ama üniversitede aldığınız o eğitimleri mesela hemen akabinde uygulasanız yapsanız çok daha rahat belki uygulayacaksınız kullanmaya başlayacaksınız ama şu anda meslek hayatına geçtiğiniz zaman acaba nasıl olur bunu uygulayabilir miyim nasıl daha mı iyi anlarlar şu soru tipini çözebilir miyim o zaman buna vakit kalır mı gibi sorulara cevap arıyorsunuz sıkıntı oluyor*.)

He also emphasized his views regarding the experience as practice teacher in his own words as follow: "I did not observe any mentors at the school I was a practice-teacher do any sort of activities in class. That is also important because if I had seen any teacher doing activities in class hours, I would be convinced that those activities were doable in an actual class. What I learned in those practice-teaching

hours was to discipline the class, nothing else. There must be practice schools just for practice-teachers as practice hospitals in real life. The staff there should all have a master's degree, so they can be effective. That would be nice. Materials should be use in real class environment or we should see teachers that implement activities" (Turkish version: *Staj dersine gittiğimizde öğretmenleri uygularken görmüyorduk buda bizim için etkili. Çünkü uygularken görseydik en azından gerçek hayatta kullanılabilir olduğunu anlardık. Ben staja gittiğimde ne öğrendim sadece sınıf disiplinini başka bir şey öğrenmedim. Uygulama hastaneleri gibi uygulama okulları olmalı. Burada en az master derecesine sahip öğretmenler olmalı. Böylece bize daha fazla katkıları olur. Gerçek sınıf ortamında uygulanmalı veya kullanan öğretmenleri görmek etkili olur*.)

Below table summarized the factors that teachers consider while using or not using manipulatives.

Table 4.1. Factors affecting use of manipulatives

Alkın	*Time* (for coverage of curriculum) *Availability of materials*
Esra	*Her view point* (manipulatives is not a necessity for learning mathematics and experience as student) *School Administration* *Time* (use of materials takes long time) *Grade level* (more appropriate for small levels) *Existence of appropriate material relevant to the subject to be taught* *Students' view point* (see them as toy and not accustomed to that kind of learning) Decrease control of students
Burcu	*Grade level* *Classroom size* *School Administration*
Ahmet	Lack of confidence Grade level Students' knowledge level Availability of material. Classroom management Time (use of manipulatives takes long time and not enough time left for writing and solving examples) Student's familiarities with mathematics through manipulatives

4.2.5. Views about manipulatives used in the training and real class application

In the training the researcher together with the teachers tried to learn how and where to use Fraction Bars (transparent), Pattern Blocks, Geoboards, Algebra tiles and Four-Pan Balance. According to the participant teachers, the fraction bars were appropriate for the subject of fractions as illustration of shaded parts is easy to see and compare. But they considered that students might have difficulty in understanding modeling of multiplication of fractions and division of fractions by using fraction bars. During the training it was identified by the researcher that teachers had problems regarding the modeling of multiplication and division of fractions due to lack of understanding of the logic of multiplication and division. In the training the researcher explained the meanings of 1/2 * 1/2 ; half of 1/2; and 1/2 ÷ 1/2; how many 1/2 exist in 1/2 . They had difficulty in showing division of fractions by using fraction bars. The researcher explained that pattern blocks also can be used for division of fractions with the help of activity given in Appendix F. In that activity questions were based on the fact that two hexagons constitute one whole. Although teachers understood how to use pattern blocks in teaching multiplication of fractions, Alkın and Burcu had hesitation as students could live problem for identifying two hexagons as one whole. And teachers were in the opinion that while using pattern blocks teacher should care of identifying "one whole" as showing division of fractions depends on the "one whole". The researcher together with the Esra worked on how to use fraction bars to show division of fractions on 05.12.2011 during the stay of the researcher at school. Esra with the use of fraction bars showed division of fractions and stated "we did enlargement while dividing fractions and we should divide the overlap shaded part to shaded parts". All of them considered that both fraction bars and pattern blocks were appropriate for the subject of fractions and pattern blocks can be used for other subjects like polygons, angles of polygons, etc. According to Esra, geometry sticks need to be available in all schools.

In addition, to them the geoboard is easy to use, good for geometry, and appropriate for all grade levels. Regarding the four-pan balance, they were in the opinion that it is good for showing bigger than and less than concept such as -1 < 0, -

2 >-4, 4 < 8 and equations. To them, showing negative numbers or minus as a weight in red pan do not cause any misunderstanding. But according to Esra, the way in solving equations with one unknown by using Four-pan Balance is different then the way of solving questions. To her, they do not all the time add, subtract, divide or multiply the same number with both sides of the equations. Besides they let alone the unknown and transfer the numbers to the other side or the equation with their inverse. Although in the curriculum, the equations solved as the way in four-pan balance in order to increase the speed of solving questions they explained the subject like transferring inverse of numbers. This was same for Alkın also. Burcu did not so interested in how to use the Four-Pan-Balance as she did not have six-grade students. To Ahmet, the Four-Pan-Balance was good for visualizing equations with one unknown for students.

Regarding the manipulative of "algebra tiles" the researchers identified that the participant teachers had difficulty in using negative numbers in modeling multiplication of first degree equations. For example they had difficulty in showing how multiplication of minus one and minus one becomes plus one by algebra tiles. They declared that they directly tell the rule to students and want them to show the model or identifying multiplier and multiplicand. This was also clarified by the director of the school who has 15 years elementary mathematics teacher experience. She said that teachers of grade 7 in the school did not want to ask questions in consisting negative numbers in the subject of "algebra tiles". Ahmet considered that algebra tiles were appropriate for factorization of polynomials in grade 8. However, to Burcu students in grade 8 may live problem as they forget the subject of algebra tiles in grade 7 but can be used in grade 7 as there was a subject with the name of "algebra tiles" and most of the students have problem about that subject. To them showing negative values in different color does not cause any misunderstanding.

In their classes the participants used manipulatives of fraction bars, geoboards, geometry sticks, base –ten- blocks, four-pan balance, and paper & pencil. After the application, Alkın was still of the opinion that fraction bars were more appropriate for the subject of fractions. Similar to views after training Alkın and Burcu considered that geoboard is good for teaching geometry as it is easy to use. In addition Ahmet and Alkın considered geometry sticks are appropriate for

construction of triangles, polygons i.e. in geometry. However, Ahmet changed his views regarding the base-ten blocks. After the training he was in the opinion that the manipulative was good for teaching of decimal numbers but after the application he was in the opinion that base-ten blocks were not appropriate for teaching multiplication and division of decimal numbers but appropriate for addition and subtraction of decimal numbers.

4.3. How upper elementary mathematics teachers used manipulatives in their classes

Table 4.2 presents a summary of how participants of this study used the manipulatives in their classes. The participants used fraction bars, geoboard, geometry sticks, base-ten blocks, four-pan balance, paper folding activity, and paper cutting activity in teaching mathematical subjects of fractions, angles in the circles, sides relations in triangles, operations in decimal numbers, solving one unknown equations in algebra, bisector and median in triangle and Pythagorean theorem respectively.

Table 4.2. How participants used manipulatives

Participants	Manipulatives	Grade Level & # of students	How they used material	Mathematical Content	What for
Alkın	Fraction Bars	6th / 19	Group Work (3-Person)	Fractions	Review
	Geoboard	7th / 19	Individual Hands-on	Angles in circles	Review
	Geometry Sticks	8th / 9	Individual Hands-on	Sides relations in triangles	Present the subject
Esra	Four-Pan Balance	6th / 18	Demonstration & Group Work (4-Person)	Equations	Present the subject
Burcu	Geoboard	7th / 20	Individual Hands-on	Angles in circles	Present the subject
Ahmet	Base-Ten Blocks	6th / 14	Group work (3-Person)	Decimal Numbers (Addition, subtraction, multiplication)	Review for addition and subtraction Present subject of multiplication
	Geometry Sticks	8th / 21	Group work (2-Person)	Sides relations in triangles	Present the subject
	Paper cutting activity	8th / 19	Group work (4- Person)	Pythagorean Theorem	Present the subject
	Paper folding activity	8th / 19	Individual Hands-on	Angle bisector & median in triangle	Review
	Four-Pan Balance	6th / 18	Demonstration	Equations	Present the subject

After training the researcher, together with the participant teachers, decided on which subject they would want to use manipulatives in teaching mathematics taking into account the annual plan and dates of exams. The researcher did not force

teachers to use manipulatives since the research was based on the willingness of the participant teachers. Alkın decided to use fraction bars and geoboard as she considered them to be more appropriate for the subjects of fractions and circles, respectively. Burcu was also of the opinion that the geoboard was good for directly visualizing rules of angles in circles and decided to use that material. Ahmet was the only person who voluntarily wanted to use all the materials while teaching mathematics. He decided to use base-ten blocks in grade 6 while teaching decimal numbers and algebra tiles in grade 8. Although he decided to use that material, he could not use it as he did not move on that subject before the semester holiday as planned in the annual plan. However, he used geometry sticks, paper folding and cutting activity in grade 8 and four-pan balance in grade 6. Esra, is the teacher having the most experience in the use of manipulatives, did not say anything about which manipulative should be used on which subject. Although she stated in the interview that geometry sticks should be available in the schools, she did not want to use them when the researcher informed her about the activity of side relations in triangles. She always showed a positive attitude towards the use of manipulatives but she did not use them. Therefore, the researcher requested the head of mathematics department to remind her to use manipulatives in the subjects appropriate for the use of manipulatives. The only subject that she could apply manipulatives was in "algebra" in grade 6. After then she informed the researcher that she would use the four-pan balance in algebra.

The researcher had an impression that Alkın and Esra thought that doing one activity is enough for me to write doctorate thesis. Therefore, the researcher told them doing such kind of activity is not helpful only for her but for them, too and it is especially beneficial for the students. The researcher made all preparations for Alkın, Burcu and Esra to do this activity. However, the researcher together with Ahmet decided on the activities to be done and prepared everything together. The researcher also reminded the teachers that they could use algebra tiles while teaching "algebra tiles" in grade 7^{th} and factorization of polynomials in grade 8^{th}. Alkın and Burcu were the teachers of grade 7^{th} students and they did not want to use them. They further stated that students had difficulty in understanding this subject. The researcher examined the second exam questions and informed mathematics

department that most of the students did not answered the question correctly on the algebra tiles. She gave statistical information on how many students answered the question, how many of them answered it correctly by using algebra tiles, how many of them gave wrong answer. In addition, students who got point from this question did not solve it by using algebra tiles but by doing multiplication. The researcher considered that indeed they did not want to use algebra tiles since they thought that students had difficulty in understanding with this method, but they stated that "we have no time and we need to solve lots of questions".

The researcher used "Math Manipulative Observation" checklist of Ernest (1994) in order to understand the degree of implementation and students' responses on the manipulatives. After the application as explained in Chapter III- Research Methodology, the researcher took both the teachers' and students' views about the application. Below how teachers used the manipulatives and what their views were after the application and how students acted in the activity will be presented based on the activity and the participants.

The Participant: Alkın

Lesson 1 (Grade 6th)

Subject: fractions (ordering, addition, subtraction, multiplication and division)

Duration: one lesson hour

Group work (3-Person)

Material: fraction bars

Number of students: 19

How to use:

Alkın used the fraction bars to review the subject. At the beginning of the lesson she gave brief information about the aim of the lesson and the activity. She gave definition of fraction and introduced the material to students. However, she did not give time to students for free exploration of materials and directly started the

activity. She directly started activity and in general answered the questions by herself and showed directly the results with fraction bars. For example, while ordering the fraction with same denominator she stated that we looked at the shaded part and order. In addition, while subtracting of fractions some of the students stated that they didn't understand how to do it but again she said "*we have no time let me listen we drop the dark one and count the shaded area*". In addition, she passed over the questions in the activity sheet very quickly by stating there was no time and therefore, students could not reach her speed. She did not let students make noise while discussing within groups. During the activity it was observed that students did not understand the logic behind modeling of multiplication and division of fractions. Regarding the multiplication of fractions they just memorized "count the dark shaded area that overlap". The teacher also did not make this point clear for the students although the researcher taught it and stated that most of the students do not understand the logic behind this modeling. While answering "how many times ¼ exists in ½" she directly stated ""*we do division and what we do is first fraction remains same and the second one turned opposite and multiplied*".

Students' reactions:

Some of the students tried to do everything in the activity but some of them were lost during the activity. They said that they did not understand, but the teacher did not give time by stating there was no time and the answer is this. With the help of material student easily compared the fractions with same denominator, same numerator, or different denominator. But, they had problem on understanding logic behind the multiplication and division. They did not understand that multiplication of fraction means finding how many parts of the others. In addition they did not understand the logic of division as it means to find how many times a fraction exists in the other fraction. Besides the fact learning modeling of the multiplication of fractions is one of the objectives of the subject of fraction in current mathematics curriculum, students just memorized the rule as counting the shaded area.

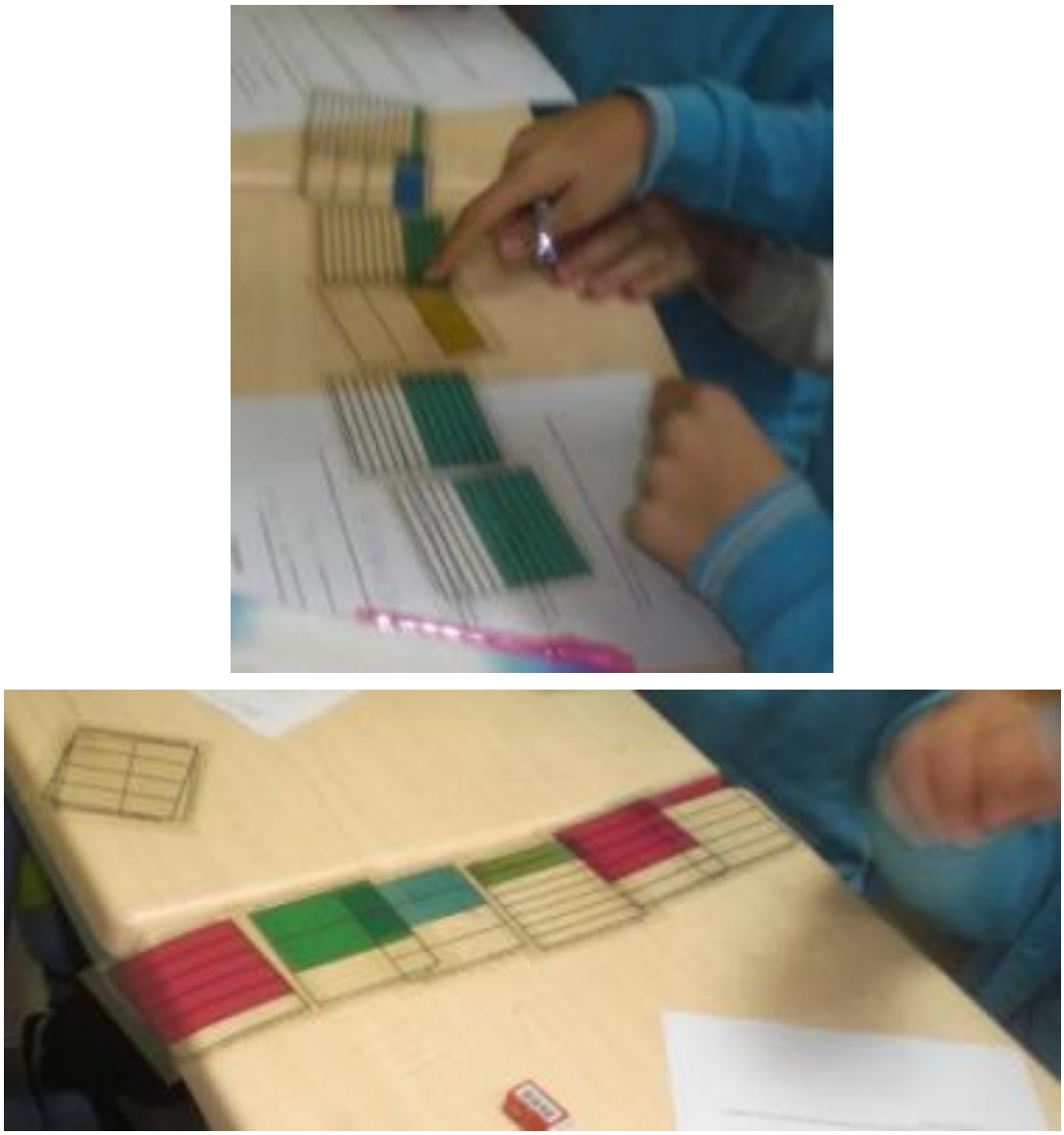


Figure 4.1. A scene from activity done in the class

Teacher's view after application:

She stated that the activity was helpful but it would be more effective to use material while teaching subject. She stated that as it was the last lesson of the day students were tired therefore, did not understand and it was difficult to control class however, it was helpful and wanted to use them next years. She also requested information on how they can provide materials for next years. She was happy with the lesson and result but it was clear that some of the students did not understand the

logic behind multiplication of fractions by area modeling. The researcher could not take the views of the students after the activity as it is the last lesson of the day and week.

Lesson 2 (Grade 7th)

Although she decided to use material for explaining subject she used it for review of the subject.

Subject: Angles in the circle

Duration: one lesson hour

Material: geoboard and rubber bands

Number of students: 19

How to use:

At the beginning of the lesson she showed the material and stated that this is "geoboard" and by using this material we will review what we have learned about circles. Students were interested in use of material. This time she gave time for students for free exploration of material. She asked extra questions to students while doing activity such as "What is the biggest chord?", "How the length of chord change with respect to radius". Like previous application she asked questions to class but without giving enough time to students she answered them thus students could not catch her speed. Some of the students stated this fact when requesting their view points about the activity as below:

> *"I had never used them but I think they were fun and instructive. I felt like playing a game but I was also in a lesson. I think such visual materials should be more frequently used. It would have been better if each of them had been explained clearly. But still, I believe they reinforced the subject that I learned better".*

Students' reactions:

Students enjoyed the lesson and easily constructed the requested figures by using geoboard only one of the students had problem with constructing figures and

therefore, did not like the lesson. Although in the lesson she said this to teacher, teacher just showed the answer by holding up geoboard and did not explain in detail to student. In general, students seemed to participate in the activities.

Figure 4.2. A scene from activity done in the class

Teacher's view after application:

According to her, use of geoboard was beneficial for students to strengthen the subject of circle with active involvement of students. In addition, use of material is easy and makes subject visual for students. She wanted to use material in next years and recommended teacher to take care of classroom management as students actively involve in the lesson, be prepare and ready for the lesson before the activity and inform students about how to use material. Although she stated with the use of

material student better learn and understand the concept and provide permanence of knowledge, she declared her hesitations with her own words as “by traditional teaching I can solve lots of questions but this kind of teaching takes more time and limited time left for solving questions” (Turkish version: *Klasik yöntemle daha çok soru çözebiliyorum ama bu yöntem daha fazla vakit aldığı için soru çözümüne daha az zaman kalıyor*).

The researcher asked question whether she realized that all the students did the same figure for “central and peripheral angles looking at the same chord” or not. She stated she explained the subject by drawing that model and students did the same model by using geoboard. This was also valid for other class doing this activity.

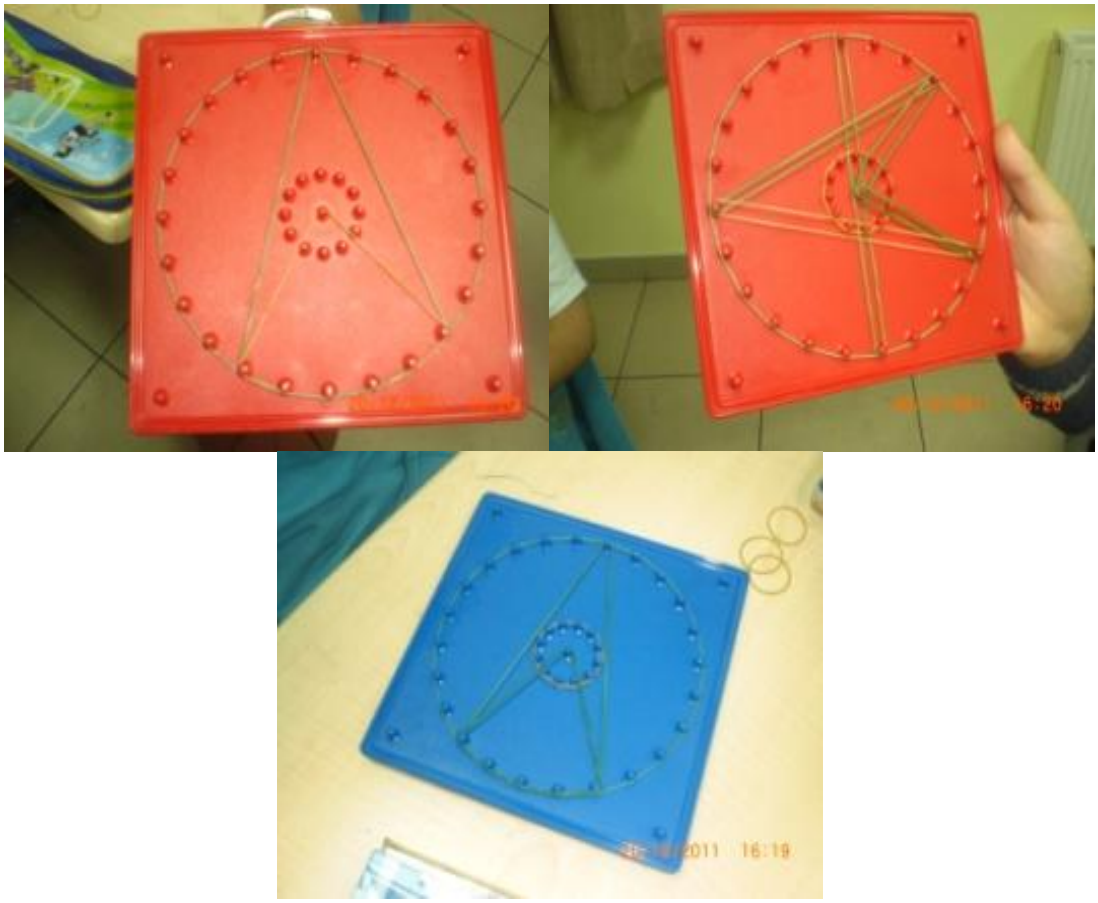


Figure 4.3. A scene from activity done in the class

Lesson 3 (Grade 8th)

Teachers also attended lessons of students who take lower score in sample exam of SBS on every Wednesday 8th lesson. In this class teachers solve questions for students and sometimes make review of subjects. When she was responsible for the class she wanted to do activity since in previous day other teachers talked that activities would be more beneficial for these kinds of students as they have difficulty in learning of mathematics. Participant teachers of Alkın, Esra and Burcu were in the opinion that students have difficulty in mathematics get more benefit from the use of manipulatives in learning mathematics as they see what they have learned and may be do not forget in a short period.

Subject: Side relations in triangle

Duration: one lesson hour

Material: geometry sticks

Number of students: 9

How to use:

At the beginning of the lesson she tried to understand whether the students knew the subject or not. They did not know the mathematics subject. She explained the aim of the lesson and distributed geometry sticks together with the activity sheet. Students were happy and interested in materials and tried to construct some shapes. This time teacher gave time students to explore the material. But again teacher started directly doing the activity. At first she asked students to construct but later she showed what she has constructed. Due to the nature of the activity she asked questions like "Can you do?"," What can be the reason?", "Show me the biggest side". In addition she requested students to make acute angle triangle, obtuse angle triangle and right angle triangle.

Students' reaction:

Students had poor mathematics background and therefore had difficulty in constructing shapes. They did not make implication for the property of sides in triangle therefore teacher stated the rule and requested them to write the rule on activity sheet. Students had difficulty in concentrating on the lesson and some of

them disliked the activity since they came to that class with expectation of solving lots of questions and learning how to solve type of questions that they might face in SBS.

Teacher view after application:

At the beginning of the lesson she stated "I do not want them to do well but I think they like and will learn something" therefore at the end of the lesson she was happy with the result.

The participant: Burcu

She mentioned her willingness to use geoboard while learning how and where to use material. According to her, with the help of this material students can easily understand the subject as it is easy to visualize the rules and facts by this material. Therefore, she informed the researcher that she can do the activity while teaching subject of angles in the circle. She together with the researcher discussed how to use the material and the researcher prepared teacher note for the use of material. Although she knew that the activity last one lesson hour she said that "*I can only give 25 minutes for you*". Thus she seemed that as she has done the activity due to the request of the researcher. Although before the activity the researcher warned that 25 minutes was not enough for the activity she did not take care of it. In addition, she requested the researcher do the activity but after explanation of the researcher she did the activity. The researcher observed one-lesson hour of the teacher. At the beginning of the lesson, teacher solved the question of previous lesson. After then she started writing rules of the subject on the board and said to students "*after finishing writing we would solve questions for SBS*". She wrote everything on the board and wanted students to write them on their notebook. One of the students asked teacher "*How long are we going to write*?" and she just said "*Keep writing!*" Although one of the students said "*I did not understand the rule*" she said "*Just write later on we will solve examples and questions*". Thus she used traditional teaching during this lesson.

Lesson 1 (Grade 7th)

Subject: Angles in the circle

Duration: 25 minutes

Material: Geoboard and rubber bands

Number of students: 20

How to use:

While distributing the materials she stated "What you are holding in your hands is a toy. You'll play with it. That's why I say this. Geometry board (geoboard) is the educational material". (Turkish version: *elinizde tuttuğunuz oyuncak oynayacaksınız şimdi o yüzden böyle diyorum. Eğitim materyali geometri tahtası*). This sentence affected students. She gave time for students to explore the material. But there was noise and students threw away rubbers to each other. Therefore, she warned students to become calm by stating "It is a toy but it is an educational toy. We didn't give them to the smaller grades but you, thinking that you would treat them better". (Turkish version: *oyuncak ama eğitim oyuncağı bir amacı var. küçük sınıflara neden vermedik size verdik düzgün davranırsınız diye*). Teacher requested students to construct figures but most of them did not do. She showed the models that she has constructed in front of the class. Due to the time limitation, the activity could not finish.

Students' reaction:

Although at the beginning of the activity students were interested in the lesson after hearing the view of the teacher regarding the material; it is a toy; they played with the material rather then doing activity. Students did not want to construct figures requested by the teacher. They made different figures even they threw away rubbers to each other. Only one of the students did everything in the activity. The researcher could not take the views of students as they did not do the activity as a whole and taking their view did not reflect their real view points. But during the activity it was seen that students were familiar with the materials since they had already used them in grade 3rd, 4th, and 5. Students also declared that their last year mathematics teachers used the material while teaching geometry.

Teacher's view after application:

After the application she declared that she was not aware that students were familiar with the material. To her, material was very simple, and easy to use. Thus students can easily play with the material and directly visualize the rules with the help of material. According to her, material was appropriate with the current mathematics curriculum, the subject and could even be used in grade 6^{th}. She answered the question of "under what condition you will use the material in next year" as "*if time is available*". She did not show any willingness to use material either in this year and next years. Moreover, to her students were so active and tried to make lesson like a game by throwing rubbers and using geoboard like a guitar. She did not state any recommendation for teachers that use the material for the first time as it was easy to use the material.

The participant: Esra

She used the Four-Pan- Algebra balance for teaching the new subject of solving equations with one unknown in algebra.

Lesson 1 (Grade 6^{th})

Subject: Equations with one unknown

Duration: Two lesson hours

Material: Four-Pan Algebra Balance

Number of students: 18

How to use:

At the beginning of the lesson, she reviewed the definition of equations and unknown in equations and later explained the meaning of equations with one unknown. She used the examples of two-pan balance in the lesson plan by showing on the smart board. The classroom is in U-shape and she tried to give speech to every student. There was an interactive communication with students during the lesson. She requested students to solve questions by taking and putting on two pan balance.

Students had difficulty in understanding the balance and teacher stated "*assume that you do not know addition and subtraction, you have two-pan balance and has to find the unknown*". One of the students explained how to solve and teacher showed what to do by using four-pan balance as if two-pan balance namely by just using inner two-pan. After solving examples in the lesson plan, she showed four-pan balance to class. She wanted them to realize that the indicator show the lighter part, zero principle and yellow pans for negative, weight of empty cup is one chip. Nearly 15 minutes she tried to make them familiar with the four-pan balance. She demonstrated that by adding and subtracting same number to both sides of equations did not affect the balance. Students observed this and seemed to have understood. She also modeled division of equation with same number and subtraction of same number to both sides of the equation. She modeled 2x+1=5 on four-pan balance and requested students to solve question by using four-pan balance. Most of the students wanted to solve and she chose one of them. The student added one chip two red pans and said that "*by adding minus 1 to both sides the balance did not change. Thus 2x= 4*". The student stated that "*we could group cups and chips in two and x is 2"*. The teacher also requested student to write on board what he did by using four-pan balance. After solving 3 examples she divided students into four groups, and requested group one to prepare question for group 4. The first group came together and prepared question by using four-pan balance. By doing this, they better understood the logic of solving equations with one unknown. Next group came together and firstly they wrote in symbols the represented one unknown equation and later tried to solve by using four-pan balance.

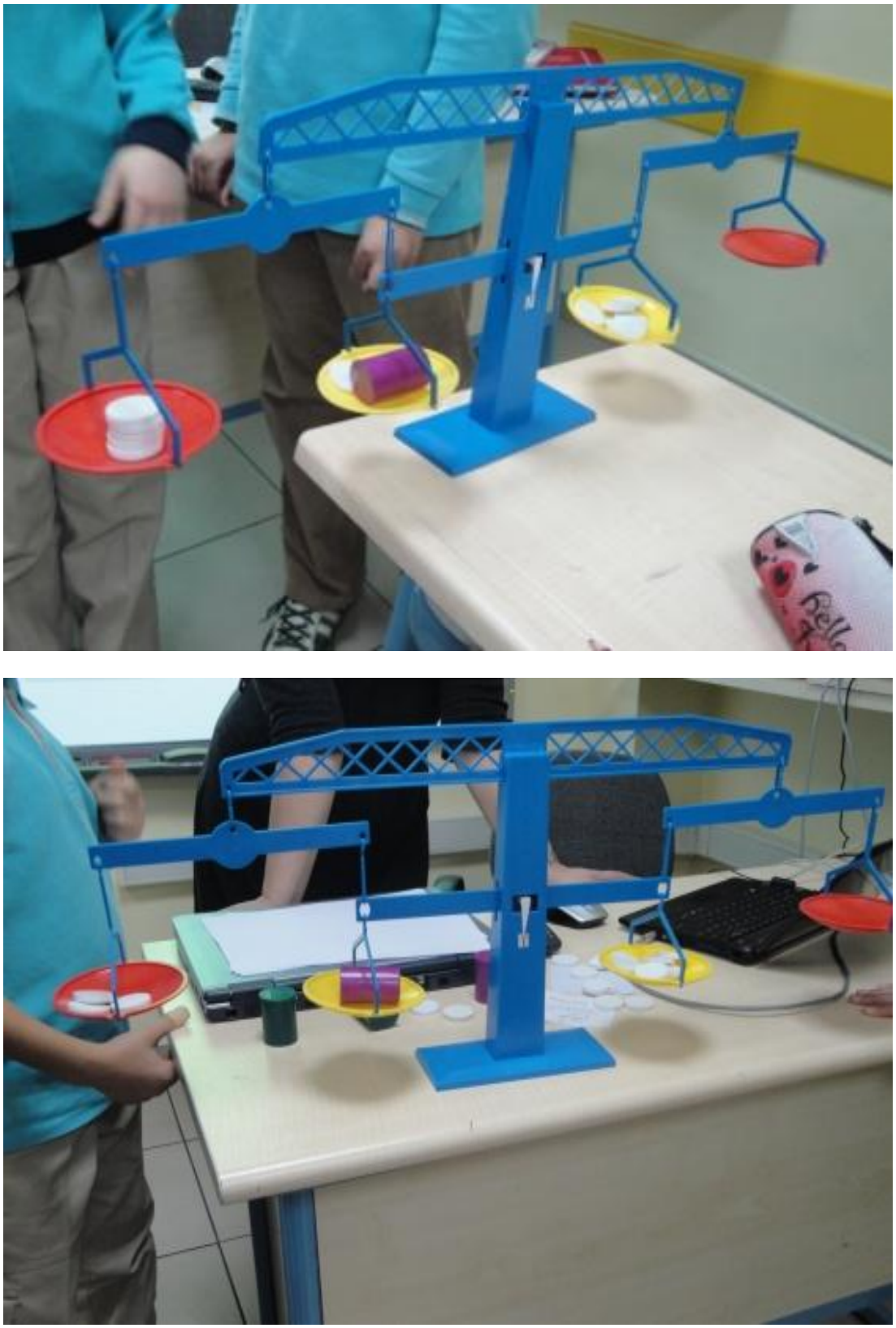


Figure 4.4. A scene from activity done in the class

Students' reaction:

While entering the class with four-pan balance students were surprised and could not any make connection with algebra. During the lesson they did not have any problem with four –pan balance and were happy with the material. With the help of material they visualized addition, subtraction, multiplication and division of the equations with same number. In addition, even in brake time students tried to use four-pan balance for representing and solving questions.

Teacher's views after application:

She considered that although with the help of four-pan balance the subject of equations with one unknown more concrete and visual, students had difficulty in understanding mathematics in four-pan balance. According to her material enabled students to pay attention to subject rather than helping them understand the subject. But she considered that the material was good to show equality, inequality, small, and big concepts and appropriate for grade 6^{th} and 7^{th}, and may even better for grade 7^{th} as students of grade 7^{th} since they know negative numbers. She also declared that they do not solve questions like adding, subtracting same number to both sides all the time as solving questions like this way takes time. Therefore, they solve questions just let alone the unknown and transfer the opposite of numbers to other side. To her, students behaved as in other lessons and have fun. She organized groups at the time of lesson and therefore group 3 consists of students that have difficulty in mathematics therefore she recommended teachers to plan everything before the lesson. She also recommended use of four-pan balance as two-pan balance at first for better understanding the concept of balance. According to her, time was important for deciding use and not use of manipulative. Besides, she was in the opinion that use of manipulatives decrease the control of teacher over students and stated that "*today you were in the class and during the group work you stayed near the materials and control the groups and therefore I could control the rest of the students. But if you were not in the class, there could be noise in the class and students did not interested in the lesson*".

The participant: Ahmet

Lesson 1 (Grade 6th)

Before the activity, teacher and the researcher discussed how to use the material and what kind of questions to ask. While using base-ten blocks in multiplication and division teacher had difficulty and stated "*I really do not fully understand the logic of multiplication by L-shape model*". But he did not disregard to use manipulatives. He was curious about the students' reactions and effects of material on students' learning.

Subject: Multiplication of decimal numbers

Duration: Two lesson hours

Material: Base-ten blocks

Number of students: 14

How to use:

At the beginning of the lesson teacher explained that they will do activity for learning multiplication of decimal numbers by using base-ten blocks. He first introduced the material and divide students into groups consisting of three person. He gave time for students to explore material. He made students discover the relation of materials between each other by asking questions and students could easily understood the relation as they were familiar with the material. He requested students to model some decimal numbers. Students showed decimals by using materials easily but while showing in general they put tens on a whole. For instance while modeling 0,21 students put 2 tens and one percent over a whole as seen in below picture.

Figure 4.5. A scene from activity done in the class

After doing addition and subtraction of decimal numbers by using base-ten blocks teacher wanted students to use base-ten blocks for multiplication of decimal numbers. He asked questions how we can use base-ten blocks in multiplication. One of the students stated that we transfer the decimal numbers into fractions and made multiplication. Only one of the students made connection with modeling multiplication of fractions. Later he gave a clue by saying students put the multiplier and multiplicand on L-shape form. He explained how to model on the board and asked students questions different from the activity sheet. But as he asked different questions students had difficulty in modeling due to the existence of not enough material. He wanted students model the multiplication on their desk and requested one student to draw model on the board by explaining the logic.

Students' reaction:

Students were happy for doing group work but as they were not accustomed to do group work they had difficulty in sharing base-ten blocks and doing activity as a group. They made noise and built towers by using base-ten blocks.

Figure 4.6. A scene from activity done in the class

Students modeled everything even symbol of multiplication and equation with base ten blocks as can be seen below.

Figure 4.7. A scene from activity done in the class

While modeling multiplication they had difficulty in understanding logic and tried to do multiplication by converting decimal numbers into fractions. Only one of the students who made connection with modeling of multiplication of fraction did the multiplication of decimals with base-ten blocks easily.

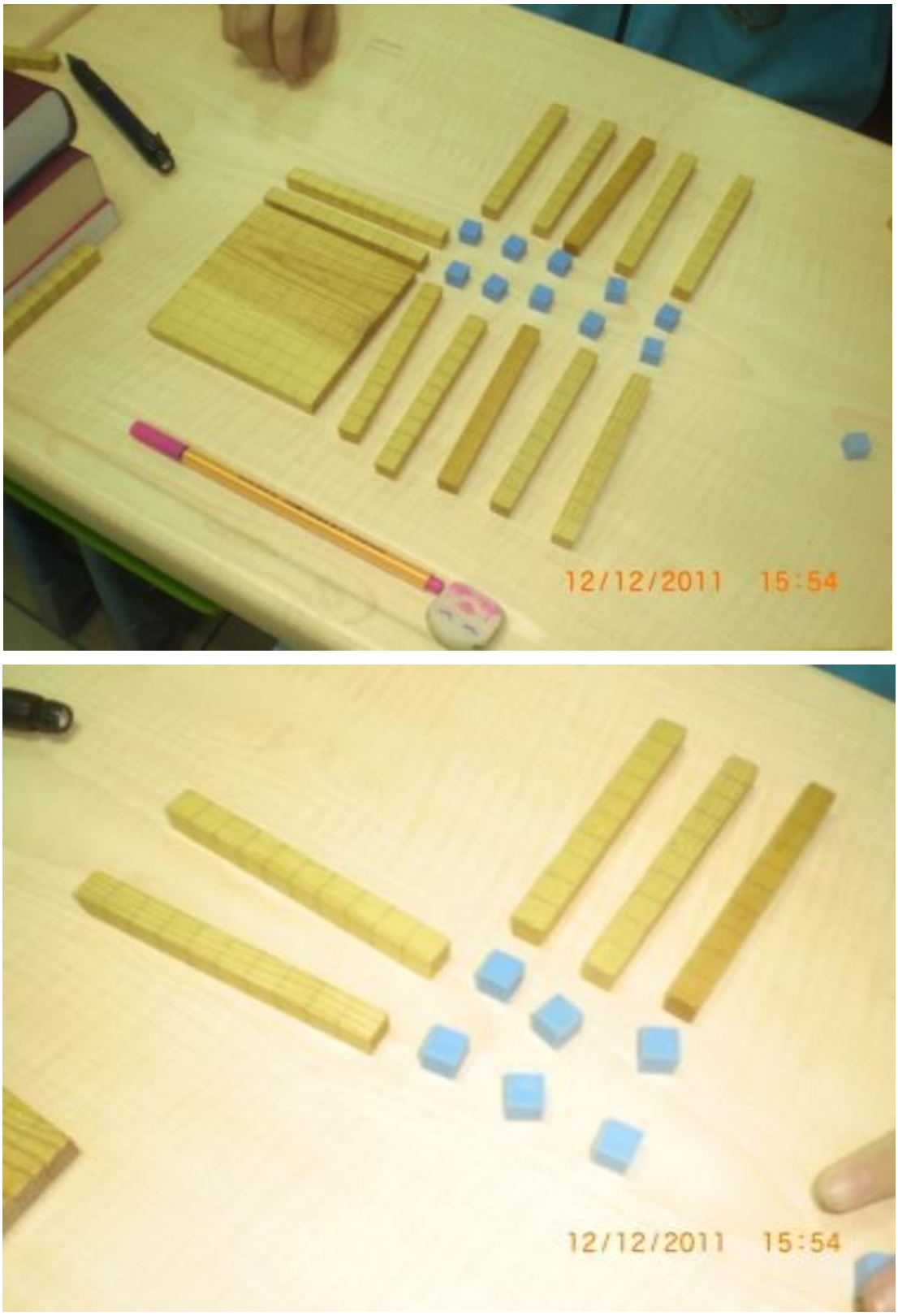


Figure 4.8. A scene from activity done in the class

At the end of the lesson students modeled multiplication of decimals without using base-ten blocks as seen below:

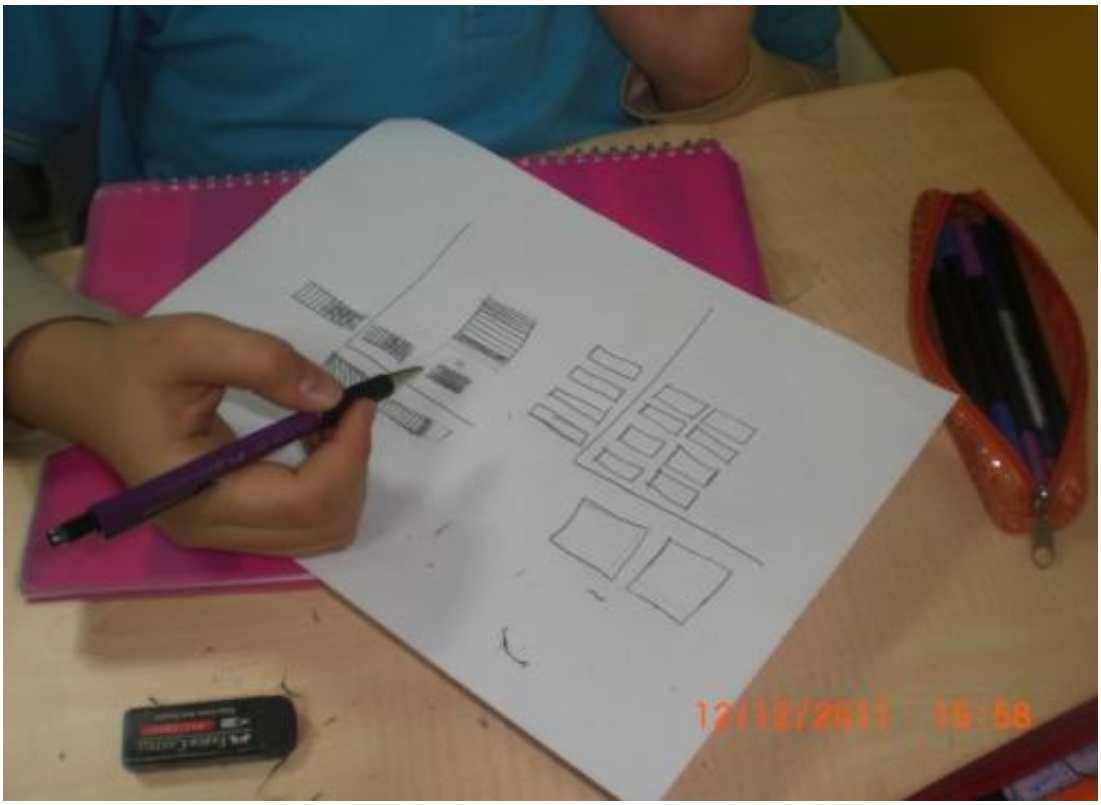


Figure 4. 9. A scene from activity done in the class

Teacher's view after application:

Before the activity he wondered about how the activity would pass as he did not use such kind of material in real class environment. After the application, he was in the opinion that both teacher and student should know the material well and it is difficult for a student to explore the multiplication on their own with base-ten blocks. Therefore, the lesson seemed to be as demonstration. He considered that material is appropriate for addition and subtraction but not appropriate for division. Therefore, did not want to use material for teaching division. To him, students' behavior was

completely different then other lesson as they played with material, made noise and it was difficult to control them. Therefore, he recommended teacher for the first time of using material take care of the student management, well know the material as whole, ones, tens, percents and relation between each other. In addition he recommended teacher to explain multiplication of decimals not by using L-shape just explaining logic of multiplication as in multiplication of fractions. He stated that "*in the next lesson I explained it like in modeling multiplication of fraction and students understood the subject*". He wanted to use material in next years since uses of materials provide different perspectives to students. He did not want to use the material for teaching multiplication or division but for addition and subtraction of decimal numbers. At the end of the activity he was in the opinion that with the use of manipulatives limited time was left for writing and solving questions.

Lesson 2 (Grade 8th)

The teacher wanted to use geometry sticks while explaining relation of sides in triangle. The researcher and teacher discussed how to use and decided to give material to students and wanted them make triangle by using material (Appendix, G). Before the activity he had concerns as students have difficulty in understanding the measurement of distance between two points on sticks is one.

Subject: Triangle

Duration: One lesson hour

Material: GeometryGeometry sticks

Number of students: 21

How to use:

At the beginning of the lesson teacher informed student that they will learn conditions for establishment of triangles by doing activity. He distributed the materials to students and gave time for exploring material. He later wanted student to connect two sticks together with connector and requested students to model a triangle. Students hold up triangle models and showed each other. He informed students that length of two points on geometry sticks is one unit and asked the

perimeter of the modeled triangles. Students easily found perimeter of the modeled triangles. Later he distributed the activity sheet (Appendix, G) to students and wanted them to do the requested things. Students tried to model the triangles and if they constructed requested triangles than showed the model. The teacher asked what the reason for not establishing triangle. Students tried to answer. Two of the students in the class knew the subject and teacher requested them not to tell the rule. One of the student stated "*if we connect two sides we can not reach the length of the third side therefore could not establish triangle*". Teacher requested students to write explanation on activity sheet. At the end of the activity students realized that addition of any two sides must bigger than third side for establishment of triangles. But they did not make any interpretation for difference of sides. Teacher asked students to create obtuse angle triangle, right angle triangle and wanted them to realize relation between angle and length of side. They easily stated that the biggest side opposes to biggest angle and hypotenuse is the biggest side of the right angle triangle.

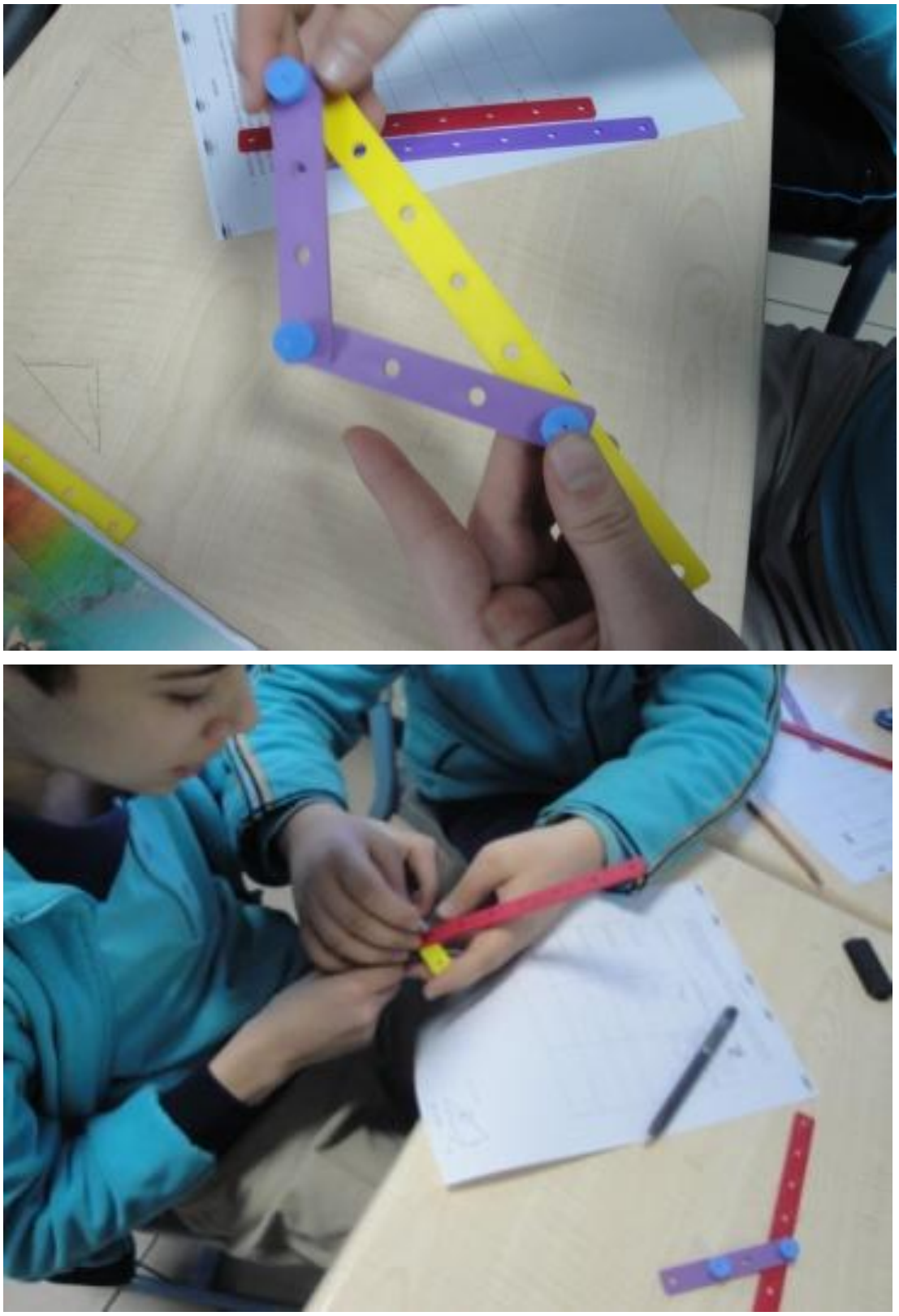


Figure 4.10. A scene from activity done in the class

Students' reaction:

Students were happy with doing activity in the lesson. They easily done the requested models and inferred the rule of addition of length of any of two side is bigger than the third side.

Teacher's view after application:

He considered that use of material was good for students to make triangle on their own. They observed whether they can create triangle or not with the given numbers by using material instead putting numbers in formula. Thus this activity was good for exploration of subject. To him, doing such kind of activity sometimes is good for taking attention of students but not all the time. In addition, to him material was appropriate for grade 7^{th}, 8^{th} and even 6^{th} for teaching and learning the subject of perimeter. He was in the opinion to use the material in next years.

Lesson 3 (Grade 8^{th})

Teacher together with the researcher worked on the activity for proof of Pythagorean Theorem. The researcher found out the proofs appropriate for paper cutting activity. The teacher tried to do them at home and considered that they were difficult for students to do as they did not learn the subject of "identity". Therefore, they decided to give template for use of area model proof of Pythagorean Theorem. The researcher also showed web-application for illustration of proof of area model. To him, using computer for teaching mathematics was good and stated "*I have used Cabri for teaching bisector and median in triangles and can do this activity by using Cabri on my own*". Therefore, the teacher prepared application for visualization the proof for area modeling by using Cabri program as seen below.

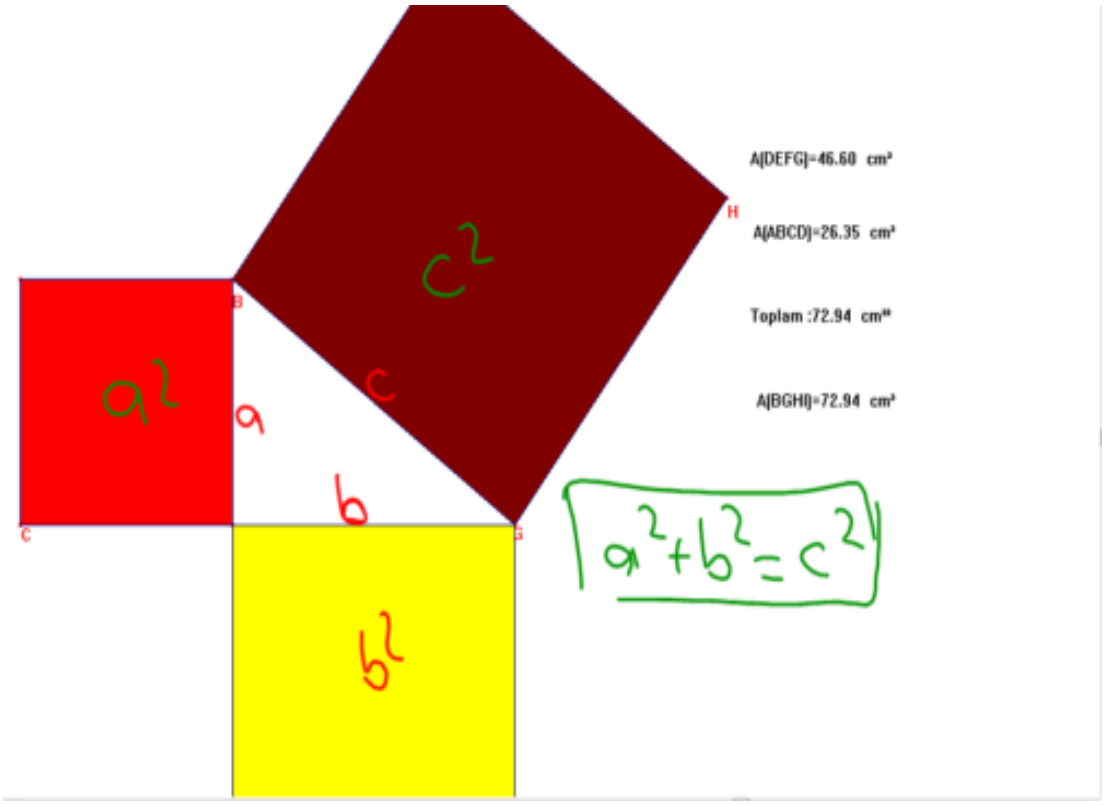


Figure 4.11. A scene from activity done in the class

Subject: Pythagorean Theorem

Duration: one lesson hour

Material: paper, scissor and glue

Number of students: 19

How to use:

Teacher began lesson by explaining the aim of the lesson and divided the class into groups consisting of 4 people. This resulted in 4 groups and two activity sheet distributed to groups. He wanted them to do the activity by cutting paper and chose a person for explaining the result of the activity on the board. He also stated "*I together with the Ms. Yıldız will identify the first group that explained well*". He walked around the class and talked to each group. After completion of activity, speaker of each group came to board and explained how they organize the parts of

the square to fit in square with length of hypotenuse, the rule and proof for it. During this part, the teacher asked well guided questions to students including “Is this rule is true for specific triangles?”, “What is the relation between sides?”, “What type of the triangle is it?” After completion of groups’ presentation he explained the theorem on the board and wanted students to write the rule on their notebook. Later, he showed the Cabri application. While doing this he explained each step namely how to draw square on sides of the triangle, side of the square is the side of the triangle and angle of triangle is 90° by measuring. Students were familiar with the Cabri program as the teachers used it before. He showed that the area of square of length of hypotenuse is equal to the sum of area of two squares of two other side of triangle by changing the length of sides of triangle. Then he started to solve questions existed in daily plan.

Students’ reaction:

At the beginning of the lesson students had less motivation due to not going volleyball match of school and possibility of holiday because of snow fall. But after 5 minutes they concentrated on the lesson. Students tried to do the activity even to them they were not good at cutting activity. Only two of the students knew the formula. Two groups easily organized cutting parts of squares to fit the square with length of hypotenuse. But the other two groups had difficulty in organizing parts in fitting the square of hypotenuse. Teacher gave clue for one group but the other did without any clue. Students seemed to like group work. They prepared their explanation of formula as see below.

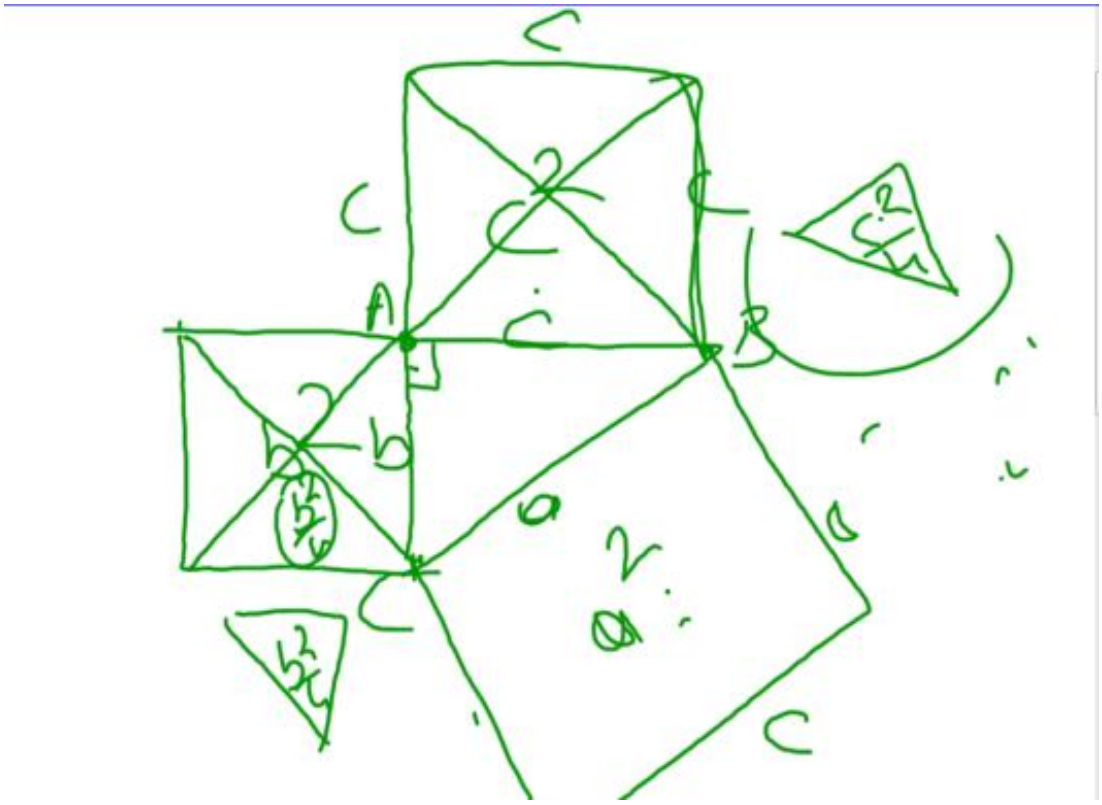


Figure 4.12. A scene from activity done in the class

All of the students stated that they like the lesson and it was good for them to see the proof of formula that they have learned.

Teacher's view after application:

To him, doing such kind of activity was good for students to see the proof of formula they have learned and stated "*students consider that solving questions is better than doing such kind of activity just because they accustomed to learning of mathematics by writing and listening. To eliminate such kind of belief we should teach mathematics in low grade like this and to satisfy teacher do activity by putting more relevant activities to subjects in textbook rather than putting lots of activity*". According to him, the applet for visualization of proof by computer that the researcher found was better than Cabri activity that he has prepared as in that applet student can see the parts of squares and how they fit in the area of square of hypotenuse.

Lesson 4 (Grade 6th)

Subject: Algebra

Duration: two lesson hours

Material: Four-Pan Balance

How to use: Demonstration

The teacher informed the researcher after he used the four-pan balance in class. Therefore, the researcher could not observe the lesson but got the view points of teacher for that experience. He used the material while teaching subject as a demonstration. According to him students could not make any connection between balance and equations at the beginning of the lesson but later they understood the logic of use of balance for algebra. In addition at the beginning of the lesson students requested teacher to teach subject as usual namely wanted teacher to explain and make them write on their notebook the rules and solving question.

He further commented that "first we should get rid of the illusion that activities are not necessary. We should start with teachers of course and educate them first in that. The students should also be trained and a new perspective should be provided so that they will get rid of the old traditional teacher lectures and the students the students take notes and solve problems. If the new style becomes a habit, things will be easier". (Turkish version: *öğretmenin gerek yok" yargısını yıkmak gerekir. Öğretmenin bu yargısını yıkmak ne kadar zor ise öğrencilerinde alışkanlıklarını yıkmak o kadar zor. Öğrenciler bu şekilde öğrenmeye alışkın olmadıkları için öğretmenin siz anlatsanız biz yazsak sonrasında soru çözsek olmaz mı diyorlar. Aslında daha iyi anladıklarına rağmen alışkın olmadıklarından onlarda da bir önyargı var.*) He was happy with the result and if available wants to use four-pan balance in future.

Lesson 5 (Grade 8th)

Subject: Angle bisector and median in triangle

Duration: Two lesson hours

Material: Paper folding activity

How to use:

The researcher tried to learn whether teachers of grade 7th did the paper folding activity of bisector and median in triangle that exists in lesson book. Teachers informed that they did not do just because of time although they went ahead the mathematics curriculum. The researcher also informed all the teachers that in SBS there are paper-folding type questions. The teacher did paper folding activity without informing the researcher for observation. He decided to do such kind of activity due to the existence of such kind of questions in SBS. He stated that although students had difficulty in doing the activity they visualized the rule and understood the concept. Furthermore, he informed that in the SBS trial exam there was a question about median and students did it. He explained his view point about such kind of activity as "teachers should understand that things are different now. The exam type and the questions are also different now. The question or problems can be easily solved if the core of math is clear to the students. The questions are more activity oriented. When my students and I tried finding the median line and bisector by folding a paper, they had some difficulties but later when they got a question in a mock exam, they understood its importance".

4.4. Elementary students' views about use of manipulatives

The researcher used the Appendix B "Students Evaluation Form" as explained in Chapter III Research methodology for learning students' views about use of manipulatives and the used manipulative material. As mentioned in the above section the researcher could not take the views of students in the activity of fraction bars as it was the last lesson of the week and activity finalized while the bell was ringing. In addition, in the activity of geoboard done by Alkın as the activity did not

finalize. However, based on the observations the researcher identified the views of students in those activities also.

Students seemed to like use of fraction bars but had problem in understanding modeling of multiplication and division of fractions as they do not understand the meaning of multiplication and division.

During the observation of activity on geoboard at grade 7^{th} the researcher realized that students were familiar with the material from grade 3, 4 and 5. Moreover students informed that last year mathematics teacher used that material in teaching geometry. The teacher' views of seeing the geoboard as a toy but an educational toy affected students negatively and they did not use material in learning mathematics but used for playing game.

In the below table you can see the summary of the results of students' views about the activity did by Alkın and the material geoboard.

Table 4.3. Summary of Students' view on geoboard

Like		18
Dislike		1
Previous Experience with	Yes	10
	No	9

Most of the students stated that they want to learn mathematics especially geometry like this and mentioned that they feel both like playing and learning. According to students, that kind of learning makes students have positive attitude toward mathematics and learn better the concepts. One of the students mentioned that he dislike the lesson and wrote that normal lessons are more enjoyable to him. After the activity, students in the class spoke out that they wanted to see mathematics

lessons like this but the student who dislike the activity stated "aren't we too old to learn mathematics by having fun" (Turkish version: *eğlenerek matematik öğrenmek için büyük değilmiyiz*). Nearly half of the students were familiar with the material as they have used material in grade 3, 4 or 5 in learning subject of square, rectangle, and polygons. Below examples of views of the students in English was presented.

> "*I had used a geometry board at another school before. I had a lot of fun during the lesson because I reinforced what I'd learned and I felt that I learned it better. I think in this lesson I learned by playing games*".

> "*I had used a geometry board when I was a 3rd grader while learning the square, the triangle and the circle. I felt like learning by practising and at the same time playing a game. I liked this lesson. Because I think it was better and fun. I've understood that such activities make learning geometry more fun*".

> "*It was really good and beneficial for us. I hadn't understood the circle much before. But while doing these, I felt I was learning and having fun. Using it was really easy. It was very enjoyable for me. I have no idea about what the others think but I think it is so obvious that you make mathematics enjoyable*".

Regarding the activity did by using geometry sticks in grade 8th by Alkın, summary of the students views can be seen in the below table.

Table 4.4. Summary of Students' view on geometry sticks

Like		5
Dislike		4
Previous Experience with material	Yes	-
	No	9

Below you can find the students' views on activity:

Student 1: "*I liked the materials and applications. I am a visual learner and I think conducting the lesson in this way was effective. It was good for us to learn the right angle, acute angle and abtuse angle triangles*".

Student 2: "*I didn't like it because we did not solve problems. It was more like a game to me. I feel uneasy. It would have been better if we have solved problems on the board*".

Student 3: "*I learned it much more easily and I like this application a lot. But I felt as if I were a fist grader while using these materials. I think they helped us to understand the subject very easily*".

Regarding the activity four-pan balance in grade 6^{th} done by Esra , students felt happy and had fun while learning mathematics and even did not understand how time passed. Below you can find the comments of students in English about the activity.

"*I think it was the best lesson I had ever experienced because our teachers taught us the subject of equations visually, by entertaining us. I understood the subject very well. I want them to do the same in all our lessons*".

"*I think learning in this way was great. We had an enjoyable time. I learned better and I understood better. I wish it would always be like this. I liked this lesson very much*".

"*I think learning in this way made me understand the subject better. And I had no idea equations could be learned in this way. I had a lot of fun. The lesson was very enjoyable and I always want to have such lessons*".

"*It was a good lesson but in my opinion instead of the whole of the lesson, the logic must be taught within half of the lesson. In the other half, it must be in the usual way. But if it is really necessary, then the hours of math classes must be doubled. In one half, its logic must be taught and in the other half the lesson must be conducted in its usual way*".

Summary of the views of students about base- ten blocks was presented in the below table:

Table 4.5. Summary of Students' view on base-ten blocks

Like		11
Dislike		3
Feel like playing		1
Feel like playing and learning		13
Previous experience with material	Yes	12
	No	2

Most of the students were in the opinion that it was difficult to model of multiplication of decimal numbers with base-ten blocks. They were familiar with the

materials as in grade3, 4 and 5 they had used material while learning addition, subtraction and decimals. Although most of the students had difficulty only one of them mentioned that he disliked due difficulty in modeling. The other one disliked the activity due to the group members. The next one stated that "*I wanted to do the lesson in its usual way and I wanted to note things down*". Only one of the students felt himself as playing because of doing activity with friends.

For the activity of geometry sticks done by Ahmet, the students' views were as below:

Table 4.6. Summary of Students' view on geometry sticks

Like		21
Dislike		-
Previous Experience with material	Yes	3
	No	18

Three of the students used same material while learning triangle in grade 5. Only one although he seemed to like the lesson, regarding the view points of his friends he stated "I understood the subject because I knew the subject but most of my friends did not understand and requested normal lesson". But interestingly all the students mentioned that they like the lesson and understood the subject. Below you can see some comments of the students translated from Turkish into English:

> "*This math lesson was very enjoyable. I had used these geometrical shapes before. We learned the triangles and their sides by practicing. We explained the relationship between the edges of the triangle based on formulas. By noting these down on the sheets distributed to us, we ensured*

retention. I'm so happy such an activity has been prepared. It will be difficult to forget them because we did it ourselves".

"*I liked this lesson very much because hands-on learning reinforces my understanding of the subjects. We learn by having fun. I liked the materials we have used so much*".

"*It was a good lesson but it was difficult to assemble and dissemble them each time. I think it would have been enough to do it a couple of times. The subject was easy and of course enjoyable. It was a change for us and I hadn't used that stuff before. It looks like the toys of my sibling at home. In short, triangles are great!"*

Students seemed to like the activity of Pythagorean Theorem and mentioned their views as below:

"*Learning by experimenting or knowing the reason behind something makes the retention of a subject better. Thanks to this lesson, mathematics has become a much more enjoyable subject. Especially learning geometry in this way makes my learning more lasting*".

"*Pisagor is a nice rule. I knew it before but now I've learned it in a better way. The lesson was very good*".

"*It was a very good lesson. We tried to learn the results of certain things by ourselves and it was a very informative lesson*".

4.5 Summary of the findings

In this Chapter, it is aimed to understand the participants' perceptions on the use of manipulatives in teaching mathematics better. The descriptions above provided several key findings to gain insights into experiences of participants. It was observed that all participants had "traditional type" mathematics learning experiences while they were students: transfer of knowledge from the teacher to students, a chalk and a board and drilling exercises. In addition, all of them had used abacuses, beans and sticks in their primary education. Esra and Ahmet were the teachers having experience in using manipulatives during their university education as they graduated from the department of "Elementary Mathematics Education". All have different opinions about how the students can learn mathematics. To Alkın, students learn mathematics by applying learned knowledge, namely by solving lots of questions. To Burcu, the teacher should give the knowledge to students due to the nature of the mathematics and students should apply what they have learned. She was of the opinion that mathematics cannot be learned by playing games. To Esra, starting the lesson with interesting and funny examples is important to attract the attention of students. She applied traditional teaching techniques in the class. Different from the others, Ahmet was in the opinion that the use of materials makes the students understand better the subject. All of them were successful in learning mathematics at the school and had no problems in understanding mathematics. According to them, students have a negative attitude toward mathematics and this goes back to even the first years of the school. In addition, to them, if students have good relationships with their teacher, they like the teacher and they sometimes like mathematics but this is not always the case. Except Burcu, all of them stated that their experience as a student affects their teaching of mathematics. Burcu said that these are just memories and stated that those memories could only help her if she had not been good at mathematics.

All of them are aware of the fact that the curriculum has been revised. Although it has been revised and improved since 2005, the teachers, especially Burcu and Ahmet, are of the opinion that it is not fully implemented and that putting in to practice the new curriculum will require much more time. They are happy with the

revised course books and teachers' books but they are not happy with the activities in the teachers' books. According to Alkın and Ahmet, time allocated for the activities are not realistic as teachers are required to prepared for the activity, check availability of the material and make the students ready for the activity.

Analysis of the first interview protocol revealed that all of the teachers advocate the use of manipulatives in teaching and learning mathematics as the use of manipulatives makes mathematics visual for the students and decrease memorization of rules and procedures. Although they advocated the use of manipulatives, only Ahmet used manipulatives in teaching mathematics an the observed school and this was verified by the analysis of notebooks of students and observations of the classes. Esra used manipulatives in teaching mathematics in her previous school at grade 4^{th} and 5^{th} due to the request of school administration but did not use them in the observed school. Burcu and Alkın did not use as they did not know how to use them.

During the two-day training period teachers seemed to have same views with those they declared during the first interview. All of the participants declared their real views about the use of manipulatives during the stay of the researcher at the schoolbefore and after application. Alkın applied the manipulatives when she considered that she has done everything that she has planned to do and for review of a subject although in the first interview she declared that if she knows she can use. According to her, time is important while deciding to use or not use the manipulatives as students can learn mathematics by solving lots of problems and with the use of manipulatives less time left for solving questions. Burcu was in the opinion that mathematics due to its nature does not let doing such kind of activities and can be best learned through direct teaching of teacher and paper and pencil. Therefore, she did not want to use more manipulatives in her classes only use the geoboard. She did not give enough time for the activity and reflected her views about the manipulative to students by stating "… this is a toy but an educational toy". During the two-day training period she was seemed to more interested in geoboards and wanted to use that material as it is easy to use. According to her mathematics can not be learned through games. After the application she was also of the same opinion and did not want to use other manipulatives in teaching mathematics.

Esra was the teacher who knows how to use manipulatives and has more experience in use of manipulatives in teaching mathematics in real class, declared that she was willing to use manipulatives as she knows benefits of use of it but could not use just because of the time constraint as she has left behind the curriculum during the first interview protocol. According to her, availability of material, students' familiarity to learning mathematics through manipulatives, time, grade level and school administration are the factors that she has mentioned in first interview affecting her while deciding to use or not to use manipulatives. During the two-day training she behaved as she knows well and declared that she felt competent herself about the use of manipulatives. However, she admitted her real views during the stay of the researcher at the school. She was in the opinion that manipulatives are not indispensible parts of the mathematics as she did not learn mathematics with this method. Therefore, she did not want to use manipulatives in teaching mathematics. Moreover, she was stated that students have difficulty in connecting the mathematics with the manipulatives and the questions asked. Therefore, she has to solve more questions while using manipulatives in order to teach how to solve questions. Moreover, to her use of manipulatives decreases the control of teachers over students. She was in the same opinion with that she had declared after the application of the four-pan-balance. According to her, the way of solving questions by using four-pan balance is different than the way through which they solve questions and it takes more time.

Ahmet knows how to use of manipulatives in teaching mathematics and seemed willing to use manipulatives in teaching mathematics. He mentioned time, availability of material, classroom management, and grade level as factors affecting him in deciding to use or not to use manipulatives in the first interview. During the two-day training he was interested in how to use manipulatives and tried to get the electronic version of the activities that the researcher used and requested knowledge where to buy materials and find more activities. He agreed that the use of manipulatives makes mathematics concrete for the students and teachers should use them while teaching mathematics. He used base-ten blocks in grade 6 while teaching multiplication and division of decimal numbers. Before the activity he had difficulty in doing multiplication by using base-ten blocks in the form of L-shape but wanted to

use the material. During the activity students had difficulty in doing multiplication by using base-ten blocks and therefore, he did not teach division by using this material. After the activity he was in the opinion that base-ten blocks are more appropriate for addition and subtraction of decimal numbers but less appropriate for division and subtraction. He also used geometric sticks and paper cutting activity under observation of the researcher. He was in the opinion that students learn better while visualizing the rules in geometry, therefore, use of manipulatives is important in teaching geometry as well as teaching mathematics. After the applications he was stated students' familiarity with learning mathematics through manipulatives, students' knowledge level, and classroom management as factors. In addition, he was in the opinion that by using manipulatives less time left for solving questions and classroom management is important. Besides these factors, he confessed that the main reason for not using manipulatives is that he feels himself not confident in the use of manipulatives. To him, if he had used these manipulatives in the university years or seen a teacher using them in teaching mathematics in practice he would have known reaction of students and effects of manipulatives in understanding of mathematics and could use manipulatives much more. Therefore, lack of confidence in use of manipulatives was the main factor affecting him to use of not to use them. He was of the opinion that during university graduate pre-service teachers should have provided settings in which they can observe use of manipulatives in real class environment and this could be done by establishing practice schools like practice hospitals.

The analysis revealed that students were familiar with geoboards, base-ten blocks and even geometric sticks as they have used them in grade 3^{rd}, 4^{th}, and 5^{th}. It was observed that they wanted to learn mathematics by using manipulatives but they did not want to declare this as they were not accustomed to such kind of learning and have to be successful at the SBS. According to them use of manipulatives makes mathematics more concrete and visual to them.

The study indicates that use manipulatives depends on the views of students and teachers toward mathematics. If they are of the opinion that mathematics can be learned through direct teaching and by solving lots of questions, they do not want to use manipulatives in teaching and learning mathematics. Teachers' views about how

students can learn mathematics and their experiences while they were students also affect them in using manipulatives. In addition, value attributed to the use of manipulatives by the teachers is reflected to the students. Namely, if teacher thinks that manipulatives are not helpful but use them in teaching, then, students do not want to use them, either and this is observed in the observed school.

CHAPTER V

CONCLUSION, DISCUSSION, AND IMPLICATIONS

The purpose of the study was to investigate the views and the use of manipulatives by upper elementary mathematics teachers to understand the rationale behind the use and not use of manipulatives, how they use, and students' views about the use of manipulatives. In this chapter findings mentioned in the Chapter IV will be reviewed and their connections to research literature will be discussed relevant to the research questions. Implications of the study's findings for teacher education and curriculum developers and recommendations for future research studies will be given in addition to the limitations of the study.

5.1. Upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics

In this part answer of the first research question "What are the upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics?" was elaborated and discussed. All the teachers are of the opinions that with the use of manipulative materials students learn mathematics better and instead of memorizing the rules they understand the logic behind the subject and therefore do not forget in a short period of time what they have learned. In addition, for some of them manipulatives are helpful for students having difficulty in understanding mathematics. Although they favor the use of manipulatives they have their reservations as they think students have difficulty in connecting the manipulative materials with real life instances and the mathematical problems or operations they are supposed to do, which in turn leads them to solve questions on the board to

compensate the time spent using manipulatives. This shows that teachers have difficulty in bridging the gap between concrete and abstract mathematics and they haven't internalized the necessity to use manipulatives for a better understanding of subjects. They also feel uneasy as they feel they may have wasted the time allocated for the instruction of the subject matters. It also indicates that they do not know how to combine the use of manipulatives and curriculum objectives, which is the similar to findings of Moyer's (2001): "coverage of state curriculum objective was an important goal and they did not clearly see how manipulatives could be used to teach these objectives"

All of the participants argue that not all students benefit from the use of manipulatives at the same levels as students have different intelligence types. They are aware of the existence of multiple intelligence theory and being a teacher they faced with students that have different learning style such as some students learn by listening from teacher but some learn by seeing, handling.

Although all the teachers advocate the use of manipulatives in teaching mathematics, an analysis of lesson plans, students' notebooks, views of students taken in the observed lessons and observations of lessons reveal that they use traditional teaching techniques in their classes. In addition they- except Ahmet- use manipulative materials as a support to traditional teaching. These results are similar to those of Moyer's (2001): although teachers gave verbal assent to the notion that manipulatives could be used to teach mathematics concepts, their actual lessons reflected traditional teaching routines with manipulatives used primarily to supplement.

All the teachers seemed to question the adequacy of the activities in the teachers' book due to the existence of activities for simple mathematical concepts and the high number of activities. Thus they criticize the value and relevance of the curriculum. They also indicate that the time allocated for the activities do not correspond the time in reality. This is similar of the findings Keleş (2009). It seems that the main reason for criticizing huge number of activities in teachers' book is being not aware of the aim of presence of activities as these activities are given as examples to teachers and teachers can combine more than one activity or reorganize

them for using in their class. Therefore, it will be helpful to explain teachers how to use teachers' book with respect to the use of manipulatives.

The teachers mentioned different factors affecting their use of manipulatives in teaching mathematics such as not knowing how to use them, the grade level's being inappropriate, availability of materials, time constraints, students' reactions (seeing them as a toy or not being accustomed to them), school administration, classroom management, not finding materials appropriate to the subject being taught and classroom size. In fact, these are factors that are seen on the surface level. In the interview with one of the participant teachers, Ahmet said that, teachers' not using manipulatives had to do with their feeling not competent enough to use them in a confident way. Thus there is a concern that teachers are not fully competent in using manipulatives and they don't seem to be prepared for different representations, questions, and the relationship with the concepts. Therefore, solving questions is safe for them rather using manipulatives. Esra confessed, another reason is that teachers still do not consider manipulatives as an indispensable part of teaching mathematics even if they have a good command of how to use them as a result of past experiences as a student, which is the basic assumption of Professional Standards for Teaching Mathematics (NCTM,1991; p. 124): "*Teachers are influenced by the teaching they see and experience*" . This is similar to the result of Moyer's (2001, p. 178): "*Yet even if teachers have learned appropriate strategies for using manipulatives, their beliefs about how students learn mathematics may influence how and why they use manipulatives as they do*". Moreover, one of the participants resisted on the use of manipulatives in teaching mathematics as for her mathematics can be learned directly from teacher and by using paper and pencil but not by games or doing activities. Thus according to her mathematics is an abstract lesson and can be learned by taking into account it seriously. This is similar to findings of Szenderi (1996): teachers do not use manipulatives as they consider that mathematics is abstract.

In general except Ahmet, other participant teachers use manipulatives if they thought that they had enough time for covering curriculum and finalized the things they planned. However, if they do not have sufficient time they do not want to use manipulatives in teaching mathematics as using manipulatives takes much time. Moreover, even if they use manipulatives, they consider it as wasting of time. This is

in some how similar to the findings of Moyer (2001). According to the Moyer (2001), teachers categorize mathematics as "real math" and "fun math" and this categorization affect their teaching style. They use manipulatives in fun math part of lesson for enjoyment, as a reward or if there is extra time but they do not use them in teaching algorithm of procedures thus in "real math". The participant teachers showed similar attitudes towards the use of manipulatives.

Although in literature there are studies showing that teachers' lack of knowledge about how to use manipulatives (Babadoğan & Olkun, 2007; Keleş, 2009; Yenilmez & Çakmak, 2007) and lack of sufficient number of manipulatives (Keleş, 2009; Yenilmez & Çakmak, 2007) were major barrier for the use of manipulatives in mathematics instruction. However, this study shows that even when teachers are provided with the training about the use of manipulatives, are supported by the school administration, and are provided with manipulatives, the use of manipulatives is largely determined by their views/ beliefs about the nature of mathematics, how students can learn mathematics and their knowledge in using them. In the observed school, there is a teacher, Esra, who has experience in the use of manipulatives and the school has sufficient material to use. However, she seems still to be reluctant to use the manipulatives and considers that they are not the indispensible part of learning mathematics as she learnt mathematics without using them. This is similar to the findings of Isenberg and Altizer-Tuning (1984): if students have not used the materials during their own education they would be less likely to use them in their own classrooms. Again, Alkın and Burcu were the teachers who do not know how to use manipulatives but after having a short period of training they still did not want to use manipulatives in their classes. Alkın used them since she thought that she had sufficient time and already finalized all the activities that she has planned before. Burcu did not want to use them as she considers that mathematics can be learned by direct teaching with paper and pencil.

The study reveals that although new teachers are familiar with theoretical aspect of manipulatives and they have an experience in using them with their classmates, they hesitate to use them in their classroom as they have hardly any idea about students' reactions and its impact on student's learning. This is because of the fact that during their internship they do not gain experience in the use of manipulatives. This showed

consistency with the study of Putney and Cass (1988) as to them we can not expect pre-service teachers to teach differently from the way they were taught or what they observe unless we model alternative approaches in university education and provide opportunities to practice those models in microteaching and practicum.

5.1.1. Relation between upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics and their views about mathematics, teaching and learning mathematics, and mathematics curriculum.

The first sub-research question asked "How are upper elementary mathematics teachers' views about the use of manipulatives in teaching mathematics related to their views about mathematics, teaching and learning mathematics, and mathematics curriculum?" One of the participants' remarks revealed why teachers are reluctant to use manipulatives in their classes, which is directly related to their perceptions of them. Burcu is of the opinion that mathematics can be taught by using paper, pencil and the board which are the means of traditional teaching, which does not lend itself to the active participation of students. In this view, manipulatives are no more than toys and doing activities is a waste of time. Her suggestion is students' doing the activity by themselves. So she does not want an active role in this learning process. This means that teachers' views about nature of mathematics and about how it can be taught and learned affect their views on manipulatives. According to Ball (1990), prior experiences of prospective teachers give vivid images of mathematics as a fixed body of knowledge, best taught through memorization and drill and this was valid for Burcu and Alkın. Alkın is of the opinion that mathematics can better be learned by solving lots of questions and therefore time is important for deciding on whether to use or not to use manipulatives in teaching mathematics. This study revealed the fact that teachers' past experiences as a student affect their teaching style in class. For example, although Esra was the one who knew how to use manipulatives and had more experience than others in terms of using manipulatives in real class environment, she was of the opinion that manipulatives were not indispensible parts of the lesson as she did not learn mathematics in this way and she

stated that “actually girls like their mothers and teachers act like their old teachers”. This is similar to the result of Moyer (2001): Teachers’ beliefs of how students learn mathematics might influence how and why they use manipulatives as they do. This finding also confirmed the findings of Isenberg and Altizer-Tuning (1984): If students have not used the materials during their own education; they will be less likely to use them in their own classrooms.

Although the current mathematics curriculum emphasizes the use of manipulatives in teaching and learning mathematics, participant teachers are of the opinion that time allocated for the activities in the curriculum did not correspond to the time used for the activity. Thus they claimed that conducting activities in the mathematics curriculum required more time than allowed. They were not happy with the existence of high numbers of activities in the teachers’ book as there are so simple activities to reach a very simple objective. All of the teachers were of the opinion that additional resources were needed besides the teachers’ book and textbooks for the preparation of SBS. Thus not using manipulatives in teaching mathematics was related to the existence of SBS and parents view of success of students as to them students who are good at mathematics get higher score in SBS. Therefore, to most of the teachers, they have to solve lots of questions in the class for a better preparation of students and time is important for them and if they have finalized everything that they have planned including the lesson books and worksheets, they can use manipulatives. Different from others, Ahmet was of the opinion that the main barrier for not using manipulatives was the teachers. He said that they had to accept that the curriculum was changed and parents should be aware of these changes. All of the teachers declared that parents were not aware of the changes in the mathematics curriculum except the projects.

This study revealed that teachers were not ready for the implementation of current mathematics curriculum in terms of the use of manipulatives as they had not been provided with the necessary training. This finding has been supported by the findings of Babadoğan and Olkun (2006), Keleş (2009), and Yenilmez and Çakmak (2007) in which teachers do not use manipulatives due to the lack of proper training.

5.2. Upper elementary mathematics teachers' application of manipulatives in their classes

The second research question addressed "How do upper elementary mathematics teachers use manipulatives in their classes?" In general teachers do not use manipulatives in teaching mathematics although the current curriculum urges them to do so. This confirms the finding that school policies and prescribed syllabus have little impact on the use of manipulatives (Howard, Perry & Lindsay, 1996; Howard, Perry & Tracey 1997).

The participants used fraction bars, geoboard, geometry sticks, base-ten blocks, four-pan algebra balance, and paper cutting activity in teaching mathematical subjects of fractions, angles in the circles, sides relations in triangles, operations in decimal numbers, solving equations with one unknown in algebra, and Pythagorean theorem respectively.

All the participants, except Ahmet, used manipulatives due to the presence of the researcher in the school and used them if they considered that they had enough time to compensate the time spent using the material. The only participant willing to use manipulatives as much as possible in his classes was the youngest of all. He had started to study at the department of Elementary Mathematics Education after the implementation of the new elementary mathematics curriculum, 2004. In addition, during his undergraduate studies, the updated teacher education curriculum that was revised in 1998 was started to be implemented as of 2006, in which the successful utilization of elementary school curriculum is highly emphasized (Işıksal, Koç, Bulut, Atay-Turhan, 2007). As a result of such an educational background, he was aware of the importance and benefits of using manipulatives.

One of the participants' remarks typifies one of the attitudes affecting the use of manipulatives. As she herself did not consider manipulatives relevant to the teaching mathematics, and considered them as toys, while starting the activity she said: "What you are holding in your hands is a toy. You'll play with it… It is a toy but it is an educational toy". This reveals the fact that teachers' views affect their implementation of manipulatives in the classroom. Indeed, there is a connection between the value teachers attribute to manipulatives and how they use them in the

class According to Moyer (2001) teachers have categorized mathematics as “fun math” and “real math” and this categorization reflected in classroom practice in terms of the use of manipulatives. Teachers defined “fun math” as games, extra-activity, enrichment and a reward for behavior. However, “real math” referred to a lesson segment where teachers taught rules, procedures and algorithms using textbooks, notebooks, worksheets, and paper-and-pencil tasks. Moyer identified that manipulatives may be used for exploration at the beginning or “fun math” part of the lesson, or they may be used in an activity or game after the mathematics content was taught but during the teaching of specific skills or content, paper-and-pencil methods were used to teach and practice “real math”. Therefore, to Moyer, teachers allocated specific time for the use of manipulatives in class such as at the end of the class period, at the end of the week on Fridays, or at the end of the school year when district objectives were completed. Thus by doing teachers gave message to the students about the importance of manipulatives in mathematics instruction. According to Joyner (1990), teachers should model the use of materials and “think aloud” about what they represent as students are more likely to value manipulative and to use them in their own explorations when they see their instructors using manipulatives.

5.3. Elementary students’ views regarding the use of manipulatives in learning mathematics.

The third research question addressed “What are the views of elementary students about the use of manipulatives in learning mathematics?” The results of the study reveal that the students are familiar with the use of geoboards, base-ten blocks and geometry sticks because they had used them in their math classes in grades 3, 4 and 5. However, they do not use manipulatives in grades 6, 7 and 8. This result showed consistency with the studies of Memnun and Akkaya (2010). In their study they found that new mathematics curriculum is not totally implemented in all mathematics classes as seventh grade students are dissatisfied with the teaching method, having to solve many questions and examples in the lessons, and they request more enjoyable lessons. ın general students seemed to like learning

mathematics through use of manipulatives as use of manipulative make concrete and visual for them to see, make them familiar with the children But this can

An analysis of students' feedback on the use of manipulatives shows that they like the use of manipulatives in learning mathematics and want to learn mathematics in this way. Thus when the conditions are arranged for learning by using manipulatives they are willing to learn through manipulatives. Despite this view, due to not being accustomed to such kind of learning and thinking that mathematics can be learned from the teacher's solving questions on the board, they were uneasy and felt that they would rather have solved problems instead of learning the logic behind the rules, which stems from their past learning experiences. However, this belief is not inherent in all students. A few of them expressed their gratitude as they thought they had learned better, and these students were aware of the fact that they were visual learners and that learning the logic behind the rules contributed to their comprehension of the subjects. In general, students found such physical activities very helpful to understand geometry subjects as the manipulatives visualized what they had learned.

Teachers' views of manipulatives affected students' attitudes towards manipulatives and activities. When one of the teachers presented them as toys to the classroom, students did not take them seriously and played with them as if they were musical instruments and threw rubber bands to one another. This confirmed the results of Joyner (1990), Moyer (2001) and Jones (2010). In contrast, one of the teachers was enthusiastic about using them and this enthusiasm spread to students alike. As Archer (1999) suggests, enthusiasm is infectious. If teachers appear excited about what they are doing, students will show more interest in the work. Similarly, if the teacher attributes a certain value to manipulatives, students deem them important as well.

5.4. Implications

This study has implications both for Ministry of National Education in terms of implementation of mathematics curriculum and teacher educators.

Even though the current curriculum has been in practice since 2005, teachers are still of the opinion that time is needed for teachers to adapt to the new system. The reason for this view is that teachers think they lack the necessary training and they are also prejudiced against the use of manipulatives, which poses a problem. This problem can be solved through providing in-service teacher training at both public and private schools by MoNE. This training should include theoretical information such as definition of manipulatives, selection criteria, and management guideline for teachers to follows while using manipulatives besides they should learn how to use them by using them in that training. Moreover, model teachers that use manipulatives in his/her class can share experiences and answer the questions of teachers

MoNE should provide good models to the teachers who have difficulty in using manipulatives. This could be done by providing regular in-service teacher training sessions in which teachers actively using manipulatives model their use and share their experiences and recommendations to other teachers. If this is not feasible, videos showing model lessons can be published on web sites of MoNE.

MoNE should revise teachers' books as teachers complain that activities focus on only one aspect of the subject matter being taught and they are more time consuming than they are supposed to be. If activities incorporate several aspects of the subjects and if they have been tested before being presented in the books then they will be applicable and manageable in the classroom context.

MoNE should provide the necessary manipulative materials to public school and should follow the use of them by their inspectors or school administration in order to increase the level of application of current mathematics curriculum in terms of use of manipulatives in teaching and learning mathematics. In addition, MoNE should also ensure that private schools provide the necessary manipulative materials and use them in their schools as recommended in the current mathematics curriculum.

This study also shows that the existence of SBS and private courses has an effect on the implementation of the current curriculum unofficially and unwillingly. Teachers use source books other than MoNE book due to the preparation of students

to SBS and these books consist of irrelevant information relevant to the current mathematics curriculum. There is a contradiction between the subjects covered in the curriculum of MoNE and those covered in that of private sector and test books. MoNE should eliminate the irrelevant documents by checking and approving these documents by applying similar procedures for MoNE's books.

The study reveals that although new teachers are familiar with theoretical aspect of manipulatives and they have an experience in using them with their classmates, they hesitate to use them in their classroom as they have hardly any idea about students' reactions and its impact on student's learning. This is because of the fact that during their internship they do not gain experience in the use of manipulatives. Therefore, teacher educators should provide a setting in which they can practice what they have learned with real students or they can prepare videos showing the use of manipulatives in teaching mathematics in public school.

This study reveals the fact that teachers' views about nature of mathematics, about how to teach and about how students learn together with their past experience have a big influence on the use of manipulatives in teaching mathematics although they have a positive attitude toward manipulatives. Therefore, before anything else, teachers' views about nature of mathematics and how students can learn mathematics need to be changed although it may be difficult to do. Thus, it is important to identify teachers' views first and then to educate them to eliminate their negative views about the use of different techniques to teach mathematics and support them by providing settings to practice what they have learned.

5.5. Implications for further research

Recommendations for further research study:

1- Similar studies might be conducted with large sample of elementary mathematics teachers. The results could be compared to the results of those of this study to determine if the findings are consistent.

2- Similar studies might be conducted with large sample of elementary mathematics teachers both at public and private schools to determine the influence of the school type.
3- Similar studies might be conducted with teachers and students of grade 1-5 in public or private schools.
4- Similar studies might be conducted with teachers and students of grade 9-12 in public and private schools.
5- The impact of the presence of test system and private courses should be investigated in terms of implication of curriculum and students' learning of mathematics.
6- The effect of the use of manipulatives on students' conceptual understanding of mathematics together with the teachers' views on that issue should be investigated.
7- The effect of providing pre-service teachers with settings in which they can observe and use manipulatives in teaching mathematics on their use of them in their classes can be investigated. Effects of school administration on use of manipulatives in teaching mathematics can be investigated.
8- Familiarity, availability and use of manipulatives in elementary school mathematics should be investigated at both public and private schools.

5.6. Limitations of the study

The result of the study limited to the views, feelings and experiences of the 4 elementary mathematics teachers teaching in a private school to relatively small number of students.

Another limitation of the study is that providing a short training on how to use manipulatives and limited numbers of applications were done in the classroom. Thus limited number of application may not represent real views of both students and teachers.

The study was also limited to the views of students since the scope of the study does not cover how students learn with the help of manipulatives and effects of manipualtives on students' achievement.

This study was also limited by the researcher. She was present at the class while teachers were using manipulatives in their classes. This might have affected both teachers' and students' behaviors in the class. Students could not act as if she was not there and therefore might not have asked questions when they did not understand or even if they did not want to use them, they had to use them. This was also the same for the teachers; they did not act as if she was not there and might have behaved differently to their students. In addition, the researcher both collected the data and analyzed them, which may also have limited the study as her view might have influenced how she presented the data.

REFERENCES

Archer, J. (1999). Teachers' beliefs about successful teaching and learning in mathematics. ERIC Document. ED 453 077

Allen, C. (2007). An action based research study on how using manipulatives will increase students' achievement in mathematics. ERIC Document. ED 499956

Argün, Z., Arıkan, A., Bulut, S., Sriraman, B. (2010) A brief history of mathematics education in Turkey. *ZDM Mathematics Education*, 42, 429–44.

Babadogan, C., & Olkun, S. (2006). Program development models and reform inTurkish elementary school mathematics curriculum. *International Journal for Mathematics Teaching and Learning*. Retrieved December 15, 2011from Http://www.cimt.plymouth.ac.uk/journal/default.htm.

Balka, D. S. (1993). Making the connections in mathematics via manipulatives. *Contemporary Education*, 65 (1), 19-22.

Ball, D. L. (1990). The mathematical understanding that preservice teachers bring to teacher education. *Elementary School Journal*, 90, 449-466.

Ball,D.L. (2000). Bridging practices: Intertwining content and pedagogy in teaching and learning to teach. *Journal of Teacher Education*, 51(3), 241-247

Ball, D. L., & Cohen, D.K. (1996) Reform by the book: What is or might be the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, 25 (9), 6-8, 14.

Bakkaloğlu, E. (2007). *Preservice elementary mathematics teachers' efficacy beliefs about using manipulatives in teaching mathematics.* Master's Thesis, Middle East Technical University, Ankara, Turkey.

Barnett, J.C., & Eastman, P. M. (1978), The use of manipulative materials and student performance in the enactive and iconic modes, *Journal for Research in Mathematics Education*, 9(2), 94-102

Baroody, J. A. (1989). Manipulatives don't come with guarantees. *Arithmetic Teacher*, 37, 4-5.

Battista, T. M. (1986). The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by preservice elementary teachers. *School Science and Mathematics*, 86 (1), 10-19.

Bay, J. M., & Reys, B. J. , & Reys, R.E. (1999) The top 10 elements that must be in place to implement standard-based mathematics curricula. *Phi-Delta Kapan*, 503-506

Bayram, S. (2004). *The effect of instruction with concrete models on eighth grade students' geometry achievement and attitudes toward geometry*, Master's Thesis, Middle East Technical University, Ankara, Turkey.

Bogdon, R. C. , & Biklen, S. K. (1998). Qualitative research for education an introduction to

Brosnan, P. A.; and others. (1994). An exploration of change in teachers' beliefs and practices during implementation of mathematics standards. ERIC Document. ED 372949

Brown, S. E. (2007). Counting blocks or Keyboards? A comparative analysis of concrete versus virtual manipulatives in elementary school mathematics concepts. ERIC Document. ED 499231

Brunner, J. S. (1966). Studies in cognitive growth: collaboration at the center for cognitive studies. New York: Wiley.

Bulut, M. (2007). Curriculum reform in Turkey: A case of elementary school mathematics curriculum. *Eurasia Journal of Mathematics, Science & Technology Education*, 3, 203-212.

Burns, M. (1992). About teaching mathematics: A K-8 resources. USA: Math Solutions Publications.

Clement, H. D., & McMillen, S. (1996, January). Rethinking "Concrete" manipulatives. *Teaching Children Mathematics*, 270-279.

Creswell, J. W. (2007).Research design qualitative & quantitative approaches. London, New Delphi: Sage.

Cuisenaire Company of America (1994). Algebra tiles for the overhead projector. White Plains, NY: Author.

Deys, I. (1993). Qualitative data analysis: A user friendly guide for social scientist. London: Rotledge.

Dienes, Z.P. , & Golding, E. W. (1971). Approach to modern mathematics. New York: Herder & Herder.

Driscoll, M. (1984, February). What research says. *Arithmetic Teacher*, 34-35.

Erdoğan, B. (2007). *The effects of physical manipulatives with or without self-metacognitive questioning on 6th grade students' knowledge acquisition on polygon*. Master's Thesis, Middle East Technical University, Ankara, Turkey.

Ernest, P. (1989). The knowledge, beliefs and attitudes of the mathematics teacher: A model. *Journal of Education for Teaching*, 15 (1), 13-33.

Ernest, P. S. (1994). Evaluation of the effectiveness and implementation of a math manipulatives project. ERIC Document. ED 391 675

Fennema, E. (1972). Models and mathematics. *Arithmetic Teacher*, 18, 635-640.

Fennema, E. (1973). Manipulatives in the classroom. *Arithmetic Teacher*, 20, 250-252.

Garriety, C. (1998). Does the use of hands-on learning with manipulatives, improve the test scores of secondary education geometry students? ERIC Document. ED 422 179

Getgood, J. F. (2001). The effect of factor blocks, a manipulative, on student understanding of greatest common factor (GCF), least common multiple (LCM), and prime factorization (PF). Dissertation Abstracts International. (UMI No. AAT. 9994822)

Gilbert, R. K., & Bush, W. S. (1988). Familiarity, availability, and use of manipulative devices in mathematics at the primary level. *School Science and Mathematics*, 88 (6), 459- 469.

Goins, K. B. (2001). Comparing the effect of visual and algebra tile manipulatives methods on student skill and understanding of polynomial multiplication. Dissertation Abstracts International. (UMI. 3036200)

Gordon, S. N. (1996). The use of manipulatives in secondary school mathematics classroom, Dissertation Abstracts International, UMI 1380602

Hatfield, M. M. (1994). Use of manipulative devices: Elementary school cooperating teachers self-report. *School Science and Mathematics*, 94 (6), 303-310.

Heddens, J. W. (1986). Bridging the gap between the concrete and the abstract. *Arithmetic Teacher*, 33 (6), 14-17

Heddens, J. W. (1997). Improving mathematics by using manipulative. Retrieved December, 6, 2007, from http://www.fed.chuck.edu.hk/~flee/mathfor/ edumath/9706/13heddens.html.

Herbert, E. (1985). Manipulatives are good mathematics! *Arithmetic Teacher*, 32, 4.

Hinzman, K. P. (1997). Use of manipulatives in mathematics at the middle school level and their effects on students' grades and attitudes. ERIC Document. ED 411 150

Hollingsworth, C. (1990). Maximizing implementation of manipulatives. *Arithmetic Teacher*, 37 (9), 27.

Holt, J. C. (1982). How children fail. New York: Dell Publishing.

Howard, P., Perry, B., & Tracey, D. (1997). Mathematics and manipulatives: Comparing primary and secondary mathematics teachers' view. [On-line]. Available: http://www.aare.edu.au/97pap/howap045.htm.

Howard, P., Perry, B., & Lindsay, M. (1996). Mathematics and manipulatives: Views from the secondary schools. ERIC Document. ED 420 540

Hynes, M. (1986). Selection criteria. *Arithmetic Teacher*, 33 (6), 11-13.

Isenberg, P. J., & Altizer – Tuning, C. J. (1984). The matematics education of primary – grade teachers. Aritmetic Teacher, 31 (5), 23 – 27.

Işıksal, M., Koç, Y., Bulut, S. & Atay-Turhan, T. (2007). An analysis of the new elementary mathematics teacher education curriculum in Turkey. *The Mathematics Educator*, 17 (2), 41–51.

Johnson, A. K. (1993). Manipulatives allow everyone to learn mathematics. *Contemporary Education*, 65(1), 10-12.

Jones, A. (2010). Secondary mathematics teachers' views of manipulatives and their use in the classroom. Dissertation Abstracts International.University of Ottawa, Canada

Joyner, M. J. (1990). Using manipulatives successfully. *Arithmetic Teacher*, 38 (2), 6-7.

Jurgenson, R. C., Brown G. R., & Jurgenson, J. W. (1990). Geometry. Boston: Houghton Mifflin

Kagan, D. M. (1992). Implication of research on teacher belief. *Educational Psychologist*, 27 (1), 65-91.

Kamii, C., & Lewis, B. A., & Kirkland, L. (2000). Manipulatives: when they are useful. *Journal of Mathematical Behavior*, 20, 21-31

Karp, S.K. (1991). Elementary school teachers' attitudes toward mathematics: The impact on students' autonomous learning skills. *School Science and Mathematics*, 91 (6), 265- 270.

Kartallıoglu, F., 2005. Yeni ilkögretim programlarının uygulandıgı pilot okullardaki ögretmenlerin yeni program ve pilot çalısmalar hakkındakigörüsleri [*The opinions of the teachers working in the piloting schools about the new elementary school curricula and pilot studies*]. Unpublished Master's thesis, Abant Izzet Baysal University, Bolu, Turkey.

Keleş, Ö. (2009). *An investigation of elementary and mathematics teachers' views about the new elementary school mathematics curriculum.* Master's Thesis, Middle East Technical University, Ankara, Turkey.

Keller, D.J. (1993). Go figure! The need for manipulatives in problem solving. *Contemporary Education*, 65(1), 12-15

Kennedy, L. M. (1986). Rationale. *Arithmetic Teacher*, 33 (6), 6-7, 32.

Koehler,M.S., & Grouws, D. A. (1992). Mathematics teaching practices and their effects. In D.A. Grouws (Ed.), *Handbook of Research on Mathematics Education*, 51-75

Krug, I. J. (1988) The effects of teacher training, teacher attitudes and school climate on the use of manipulative materials for elementary mathematics instruction. Dissertation Abstracts International. (UMI No. 8827884)

Kung, G., & Vicchiollo, K. (1997). Four-Pan algebra balance. White Plains, NY: Cuisenaire Company of America.

Larson, C. N. (1988). Techniques developing positive attitudes in preservice teachers. In J. Worth (Ed.), Preparing elementary school mathematics teachers reading from the Arithmetic Teacher. Reston, VA: NCTM.

Lewis, K. L. (1985). From manipulatives to computation making the mathematical connection. *Childhood Education*, 61 (5), 371-374.

Lincoln, Y. S. , & Guba, E.G. (1985) .Naturalistic in quiry. Beverly Hills, Ca:Sage.

Manouchehri, A., & Goodman, T. (1998). Mathematics curriculum reform and teachers: understanding the connections. *The Journal of Educational Research*, 92 (1), 27-41

Marshall, C., & Rossman, G. B. (1999).Designing qualitative research (3rd ed.). London, New Delphi: Sage

Maxwell, J. A. (1996). Qualitative research design: An interpretive approach. Thousand Oaks, CA: Sage.

McDevitt, T. M. , Heikkinen, W. H. , Alcorn, K. J. , Ambrosio, L. A. , & Gardner, A. L. (1993). Evaluation of the preparation of teachers' attitudes and beliefs. Science Education, 77 (6), 593- 610.

Merriam, S. B. (1988). Case study research in education: A qualitative approach. San Francisco : Jossey-BassPublishers.

Miles, M. B. , & Huberman, A. M. (1984). Qualitative data analysis: Asourcebook of new methods. Beverly Hills, CA: Sage

Ministry of National Education [MoNE] (2009). İlkögretim matematik dersi (6-8. Sınıflar) ögretimi programı. [Elementary school mathematics curriculum and guide (grades 6-8)] Ankara, Turkey: Author.

Memnun, D. S. , & Akkaya, R. (2010) Primary School Seventh Grade Students' Opinions About the Mathematics Course. *Kuramsal Eğitimbilim*, 3 (2), 100-117 (Available from http:// www.keg.aku.edu.tr).

Morgan, D. L. (1988). Focus groups as qualitative research. Newbury Park, CA: Sage.

Moyer, S. P. (1998) Using mathematics manipulatives: control versus autonomy – oriented middle grade teachers. Dissertation Abstracts International. (UMI No. 3036200)

Moyer, S. P. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics*, 47, 175-197.

Moyer,S. P., & Jones, M. G. (2004) Controlling choice: teachers, students and manipulatives in mathematics classrooms. *School Science and Mathematics*, 104 (1), 16-29

National Council of Teachers of Mathematics (1973). Instructional aids in mathematics. Reston, VA: Author.

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

National Council of Teachers of Mathematics (1991). Professional standards for teaching mathematics. Reston, VA: Author.

O' Shea, T. (1993). The role of manipulatives in mathematics education. *Contemporary Education*, 65 (1), 6-10.

Özdemir, Y. İ. E. (2008). Prospective elementary teachers' cognitive skills on using manipulatives in teaching mathematics. Hacettepe University Journal of Education,35: 362-373.

Parham, J.L.(1983). A meta-analysis of the Use of manipulative materials and student achievement in elementary school mathematics. *Dissertation Abstracts International*, 96, 44A.

Patton, M. G. (1990). Qualitative evaluation and research methods. Newbury Park: Sage.

Piaget, J. (1968). *Genetic Epistemolog,* a series of lectures delivered by Piaget at Columbia University. Retrieved December, 6, 2007 from http://www.marxists.org/reference/subject/philosophy/works/fr/piaget.htm

Pedersen, J. E. , & McCurdy, W. D. (1992). The effects of hands-on, minds-on teaching experiences on attitudes of preservice elementary teachers. Science Education, 76 (2), 141-146.

Putney, L. D., & Cass, M. (1998). Preservice teacher attitudes toward mathematics: Improvement through a manipulative approach. College Student Journal, 32 (4), 626- 633. Retrieved February 27, 2002, from EBSHO Masterfile database.

Quantz, R. (1992).On critical ethnography.In M. LeCompte, W.Millroy, & J.Preissle (Ed.), In the handbook of qualitative research in education, (pp. 447 – 505).San Diego, CA:Academic Press.

Quinn, R. J. (1998).The influence of matematics methods courses on preservice teachers' pedagogical beliefs concerning manipulatives. Clearing House, 71 (4), 236 – 239. Retrieved

Raphael, D. & Wahlstrom, M. (1989). The influence of instructional aids on mathematics achievement. *Journal for Research in Mathematics Education*, 20 (2), 173-190

Reys, R. E. (1971). Considerations for teachers using manipulative materials. *Arithmetic Teacher*, 18, 551-558.

Ross, R., & Kurtz, R. (1993). Making manipulatives work: A strategy for success. *Arithmetic Teacher*, 40 (5), 254-257.

Rust, A. (1999). A study of the benefits of math manipulatives versus standard curriculum in the comprehension of mathematical concepts. ERIC Document. ED 436 395

Scheer, K. J. (1985). Manipulatives make math meaningful for middle scholars. *Childhood Education*, 62 (2), 115-121.

Serra, M. (1993). Discovering geometry an inductive approach. Berkeley, California: Key Curriculum Press.

Schultz, K. A. (1986). Representational models from the learner's perspective. *Arithmetic Teacher*, 33(6), 52-55.

Schultz, J. E. (1991). Area Models-spanning the mathematics of grades 3-9. *Arithmetic Teacher*, 39(2), 42-46.

Scott, B. P. (1983). A survey of perceived use of mathematics materials by elementary teachers in a large urban school district. *School Science and Mathematics*, 3 (1), 61- 68

Scott, B. P. (1987). Perceived use of mathematics materials. *School Science and Mathematics*, 87 (1), 21- 24

Sloan, T. R. , Vinson, B. , Haynes, J. , & Gresham, R. (1997). A comparison of pre and post levels of matematics anxiety among preservice teacher candidates enrolled in a matematics method course. ERIC Document.ED 417 137

Smith, J. K. (1983). Quantitative versus qualitative research: An attempt to clarify the issue. *Educational Researcher*, pp. 6 – 13.

Smith,L. A. (2006). The impact of virtual and concrete manipulatives on algebraic understanding. Dissertation Abstracts International. UMI No.3208964

Sobel,M. A, & Maletsky, E. M. (1999). Teaching mathematics: A source book of aids, activities and strategies Third Edition. Boston: Allyn and Bacon,

Sobol, A.J. (1998). Formative and summative evaluation study of classroom interactions and student / teacher effects when implementing algebra tiles manipulatives with junior high school students. Dissertation Abstracts International. UMI No. 9830812.

Sowder, L. (1976, October). Criteria for concrete models. *Arithmetic Teacher*, 23, pp. 468-470.

Sowell, E. (1974). Another look at materials in elementary school mathematics. *School Science and Mathematics*, 74(3), 207-211.

Sowell, J. E. (1989). Effects of manipulative materials in mathematics instruction. *Journal for Research in Mathematics Education*, 20 (5), 498-505.

Spross, P. (1964, May). Considerations in the selection of learning aids. *Arithmetic Teacher*, 11, 350-353.

Spungin, R. & Voolich, E. D. (1993) Playing with blocks and rods in college, too! *Contemporary Education*, 65(1), 24-28

Suydam, M. N. (1984). Manipulative materials. *Arithmetic Teacher*, 31 (5), 27.

Suydam, M. N. (1986). Manipulative materials and achievement. *Arithmetic Teacher*, 33 (6), 10-13, 32.

Suydam, M. N., & Higgins, J. L. (1977). Activity-based learning in elementary school mathematics: Recommendations from research. ERIC Center for Science, Mathematics and Environmental Education, College of Education. Columbus: Ohio State University.

Szendrei, J. (1996). Concrete materials in the classroom. In A. J. Bishop (Ed.), International handbook of mathematics education (pp. 411-434). Dordrecth: Kluwer Academic.

Thompson, A. G. (1984). The relationship of teachers' conception of mathematics and mathematics teaching to instructional practice. *Educational Studies in Mathematics*, 15, 105-127.

Thompson, P. W. (1992). Nations, conventions, and constrains: contributions to effective uses of concrete materials in elementary mathematics. *Journal for Research in Mathematics Education*, 23, 123-47.

Thompson, F. M. (1994). Hands on math ready - to – use games and activities for grades (4-8). West Nyack, NY: The Center for Applied Research in Education.

Thompson, W. P., & Lambdin, D. (1994). Concrete materials and teaching for mathematical understanding. *Arithmetic Teacher,* 41 (9), 556-558.

Threadgill, S., Judith, A., & Juilfs, P. A. (1980). Manipulatives versus symbolic approaches to teaching logical connectives in junior high school: An aptitude x treatment interaction study. *Journal for Research in Mathematics Education*, 11 (5), 367-374.

Tishler, R., & Welchman. (1995). Start with manipulatives for staff development. White Plains, NY: Cuisenaire Company of America.

Toptaş, V. (2008). An examination of the teaching – learning process and teaching materials used in the instruction of geometry sub-learning fields in a first grade classroom. *Ankara University, Journal of Faculty of Educational Sciences*, 41(1), 299-323

Trueblood, C. R. (1988). Hands on help for teachers. In J. Worth (Ed.), Preparing elementary mathematics teachers reading from *Arithmetic Teacher*. Reston, VA: NCTM.

Tuncer, D. (2008). Materyal destekli matematik öğretimin ilköğretim 8. Sınıf öğrencilerinin akademik başarısına ve başarısının balıcılık büzeyine etkisi. Unpublished Master Thesis. Gazi University

Umay, A., Akkuş, O., & Duatepe, A. (2006). An investigation of 1-5 grades mathematics curriculum by considering NCTM principles and standards. *Hacettepe University Journal of Education*, 31, 198-211.

Van der Sandt, S. (2007).Koehler and Grouws' framework revisited. *Eurasia Journal of Mathematics*, 3(4), 343-350

Voolich, E. D. (1997). Investigating with power solids. White Plains, NY: Cuisenaire Company of America.

Welchman-Trischler R. (1992). The mathematical toolbox. White Plains, NY: Cuisenaire Company of America.

Wiebe, J. H. (1983). Physical models for symbolic representations in arithmetic. *School Science and Mathematics*, 6, 10-86

Yenilmez, K., & Çakmak, G. (2007). Yenilenen ilkögretim matematik programındaki alt ögrenme alanlarının ögretiminde karsılasılan zorluklar [Difficulties in teaching sub-learning domains in the new elementary mathematics curriculum]. *e-Journal of New World Sciences Academy Social Sciences*, *2,* 167-178.

Yeatts, K. (1991). Manipulatives: motivating mathematics. ERIC Document. ED 355 097)

Yıldırım, K. (2008). A case study on the use of materials by classroom teachers. *Educational Sciences: Theory & Practice,* 8 (1), 305-322.

Yıldız, B. T. (2004). *Preservice teachers' attitudes toward the use of manipulatives*: *The influence of field experience and method course*, Master's Thesis, Middle East Technical University, Ankara, Turkey.

Yolcu, B., & Kurtuluş, A. (2010) A study on Developing Sixth-Grade Students' Spatial Visualization Ability, *Elementary Education Online*, 9(1), 256-274, 2010

Young, S. L. (1988). How teacher educators can use manipulative materials with preservice teachers. In J. Worth (Ed.), Preparing elementary school mathematics teachers reading from Arithmetic Teacher. Reston, VA: NCTM (Reprinted from Arithmetic Teacher, 31 (1983), 12-13.)

Zanzali, N., A., A., (2003). Implementing the intended mathematics curriculum: teachers' beliefs about the meaning and relevance of problem solving. The mathematics education into the 21st century project proceedings of the international conference the decidable and the undecidable in mathematics education Brno, Czech Republic September. Retrieved December, 13, 2006 from http://math.unipa.it/~grim/21-project//21_brno03_zanzali.pdf

APPENDIX A

MATH MANIPULATIVES OBSERVATION CHECKLIST

NAME :_____**SCHOOL:**_____
DATE :_____ **TIME :** _____

PURPOSE OF LESSON: _____

MANIPULATIVE UTILIZED: _____

HOW MANIPULATIVES WERE USED UTULIZED (DEMONSTRATION, LARGE GROUP, SMALL GROUP, INDIVIDUAL HANDS-ON): _____

STUDENTS' ATTITUDES TOWARD USE OF MANIPULATIVES:_____

STUDENTS' CLASS PARTICIPATION WHEN MANIPULATIVES ARE UTILIZED:_____

INTERACTION OF LEARNERS WITH CONTENT DUE TO USE OF MANIPULATIVES:

APPENDIX B

STUDENT EVALUATION FORM

Bu form notlandırılmayacaktır. Yorumlarınız dersin daha iyi işlenmesi için kullanılacak olup bizim için son derece değerlidir. Katılımınız için teşekkürler.

(…..) Evet	(…..)Hayır	Daha önce XXXX kullandınız mı? Evet, ise ne zaman ve ne şekilde kullandığınızı yazınız.
(…..) Evet	(…..)Hayır	XXX kullanıldığı ders hoşuma gitti. Nedenini yazınız.
(…..) Evet	(…..)Hayır	XXX kullanılması sıkıcı. Nedenini yazınız.
XXX kullanırken;		
(…..) Evet	(…..)Hayır	Kendimi öğrenmeye çalışıyor değil sadece oyun oynuyor gibi hissettim. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Kendimi hem oyun oynuyor hem de öğreniyor gibi hissettim. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Kendimi sadece öğreniyor gibi hissettim. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Kendimi sadece oyun oynuyor gibi hissettim. Nedenini

		yazınız.
XXX kullanımı;		
(…..) Evet	(…..)Hayır	Kolaydı. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Zordu. Nedenini yazınız.
XXX ile;		
(…..) Evet	(…..)Hayır	Konuyu anlayabildim. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Konuyu kolay anladım. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Konuyu anlayamadım. Nedenini yazınız.
(…..) Evet	(…..)Hayır	Tam anlamıyla tekrardı çünkü konuyu daha önce biliyordum.
Bu dersi daha iyi bir hale getirmek için öneriniz varsa yazınız.		
Bu derste neyi beğendiniz? Nedenini yazınız.		
Bu dersin hoşunuza gitmeyen yanları nelerdir yazınız? Nedenini yazınız.		
Eklemek istedikleriniz varsa yazınız.		

APPENDIX C

DRAFT FIRST INTERVIEW QUESTIONS

Tarih :
Başlangıç saati Bitiş Saati:

İyi günler. Benim adım Banu TUNCAY YILDIZ. Orta Doğu Teknik Üniversitesi Eğitim Fakültesi doktora öğrencisiyim. Öncelikle benim ile görüşme yapmayı kabul ettiğiniz için çok teşekkür ederim. Öğretmenlerin matematik öğretiminde somut materyal kullanımı hakkındaki görüşlerini öğrenmek amacı ile bir çalışma gerçekleştirmekteyim. Burada da bu yüzden bulunuyorum. İnanıyorum ki sizin deneyimleriniz benim öğretmenlerin görüşlerini anlamama yardımcı olacaktır. Şunu belirtmek isterim ki burada yaptığımız görüşme son derece gizlidir ve adınız hiçbir yerde kullanılmayacaktır. Bana sormak istediğiniz soru varsa lütfen çekinmeden sorun. Ayrıca sizin için sakıncası yoksa görüşmeyi kayıt altına almak istiyorum.

1- Adınız Soyadınız?

2- Hangi okuldan mezunsunuz
    a. Yüksek lisans/ doktora?

3- Kaç yıllık matematik öğretmenisiniz?
    a. Hangi sınıf düzeyine girdiniz
    b. Mevcut okulunuzda kaçıncı yılınız

4- Şu an kaçıncı sınıflara matematik öğretiyorsunuz?
    a. Sınıf mevcudu nedir

5- Matematiği nasıl öğrendiğinize ait deneyimlerinizden bahsedebilir misiniz?
    a. En iyi matematik öğretmeniniz
        i. Nedenleri / nasıl ders anlatıyordu
    b. En kötü matematik öğretmeniniz
        i. Nedenleri / nasıl ders anlatıyordu
    c. Bu deneyimleriniz öğretmenlik hayatınızı nasil etkiledi

6- Matematiği tanımlamak isterseniz nasıl tanımlarsınız?

7- Öğrencilerin matematiği nasıl öğrendikleri hakkında görüşleriniz nelerdir?
    a. Sınıf düzeyine göre farklılık gösteriyor mu?
    b. Etkileri
    c. Sizce neden bazı öğrenciler matematiği anlamıyor
    d. Öğrencilerin matematiğe karşı tutumları

8- Matematik dersinizi nasıl işlediğiniz hakkında bilgi verebilir misiniz?
    a. Amacınız
    b. Sizin rolünüz
    c. Öğrencinin rolü
    d. Sınıf ortamı
    e. Hangi materyalleri kullanıyorsunuz
    f. Öğretim yönteminiz
    g. Öğrencilerin tepkisi
    h. Dersinize nasıl hazırlanıyorsunuz
        i. Ders kitabı/ internet/ meslektaşların deneyimi

9- Sınıfta kullandığınız matematik öğretim tekniğine etki eden faktörler nelerdir?
    a. Öğrencilerin tutumu
    b. Veli görüşü
    c. Okul yönetimi
    d. Bakanlık
    e. Yeni müfredat
        i. Nasıl etkiliyor

10- Matematik öğretiminde etkili olduğunu düşündüğünüz fakat sizin kullanmadığınız yöntemler var mı?
    a. Evet ise hangi yöntemler/ neden kullanmıyorsunuz

11- Yeni matematik müfredat programı hakkındaki görüşleriniz nelerdir?
    a. Amacı
    b. Uygulanabilirliği
    c. Yararları
    d. Sınıf içi öğretimi nasıl etkiledi
    e. Ölçme değerlendirmeye etkisi

12- Velilerin yeni matematik müfredat hakkındaki görüşleri nelerdir?
    a. Bilgileri var mı?

13- Yeni müfredat programını uygulamaya başladığınız da karşılaştığınız zorluklar nelerdir?
    a. Hizmet içi eğitim aldınız mı?
        i. Evet ise süresi/ etkileri/içeriği

14- Sizin de bildiğiniz gibi yeni müfredat matematik öğretiminde somut materyal kullanılmasını tavsiye etmektedir.
    a. Somut materyal sizin için ne ifade ediyor?
    b. Sizce matematik öğretiminde somut materyal kullanılmasının amacı nedir?
        i. Matematik öğretimine katkısı
    c. Sizce matematik öğretiminde somut materyal kullanılmalı mıdır?
        i. Neden evet
        ii. Neden hayır
        iii. Tüm öğrenciler somut materyal kullanımından yararlanır mı?
            1. Neden
            2. Örneklerle açıklar mısınız
    d. Yeni müfredatta yer alan materyaller hangileridir?
    e. Sizce sınıf içinde matematik öğretiminde somut materyal kullanımına etki eden faktörler nelerdir?

15- Matematik öğretiminde somut materyal kullanımına yönelik deneyiminiz var mı?
    a. Evet ise
        i. Hangi materyali
        ii. Ne zaman
        iii. Nasıl (gösterim amaçlı/ grup çalışması)
        iv. Öğrencilerin tutumları nasıl
        v. Etkileri (olumlu / olumsuz)

16- Somut materyal kullanımına yönelik eğitim aldınız mı?
    a. Evet ise
        i. Ne zaman
        ii. İçeriği
        iii. Süresi
        iv. Etkisi
    b. Hayır ise
        i. Almak ister misiniz?
        ii. İçeriği nasıl olmalı (teorik/ uygulamalı)
        iii. Süresi
        iv. Eğitim aldıktan sonra materyal kullanmak ister misiniz?

APPENDIX D

POST INTERVIEW QUESTIONS

1- What is your overall idea about this activity?

2- Was the use of the XXX appropriate for the lesson? Why or why not?

3- What are the strengths of using XXX for this lesson?

4- What are the weaknesses of using XXX for this lesson?

5- What modifications (if any) should be made to make the use of XXX more effective?

6- Compare the lesson to past teaching of the topic.

   Student behavior
   Facilitation of material to be learned

7- What levels of students is this manipulative suitable for?

8- What recommendations do you have for teachers for the first time next year?

9- Under what conditions would you continue this next year?

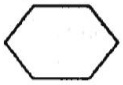
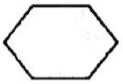
10- General comments (classroom management, preparation, other)

APPENDIX E

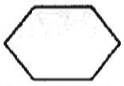
ACTIVITY FOR TRAINING OF TEACHERS

E-1 Pattern Blocks (Relation 1)

Elinizdeki materyalleri kullanarak aşağıdaki soruları cevaplamaya çalışınız.

1. Bu şekil içinde  kaç tane  var?
2. Bu şekil içinde  kaç tane  var?
3. Bu şekil içinde  kaç tane  var?
4. Bu şekil içinde  kaç tane  var?
5. Bu şekil içinde  kaç tane  var ?
6. Bu şekil içinde  kaç tane  var?

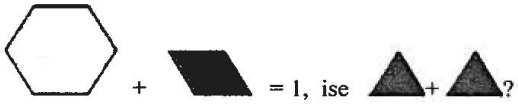
Yukarıdaki ilişkileri dikkate alarak aşağıdaki soruları cevaplayınız:

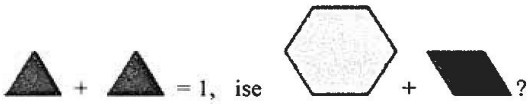
7. Eğer  = 1, ise  = ___ .
8. Eğer  = 1, ise  = ___ .
9. Eğer  = 1, ise  = ___ .
10. Eğer  = 1, ise  = ___ .

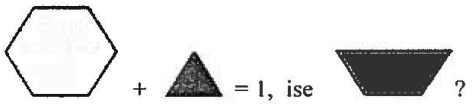
APPENDIX E

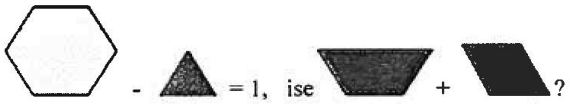
E-2. Pattern Blocks (Relation 2)

1. Eğer  = 1, ise ?

2. Eğer  = 1, ise ?

3. Eğer  = 1, ise ?

4. Eğer  = 1, ise ?

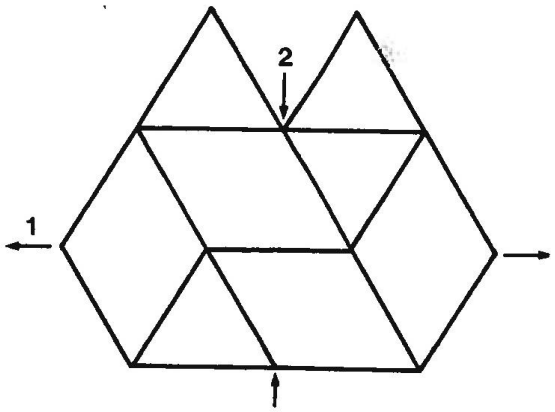
5. Eğer  = 1, ise ?

APPENDIX E

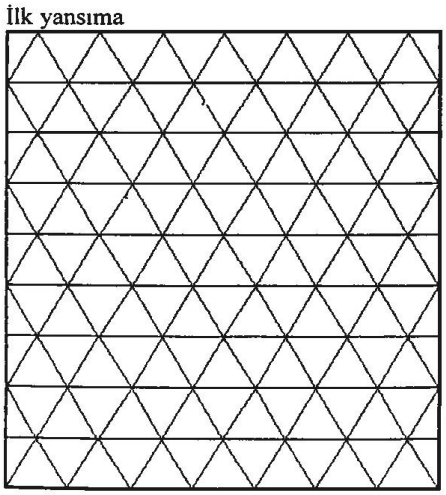
E-3. Pattern Blocks (Covering)

ÖRÜNTÜ BLOKLARI

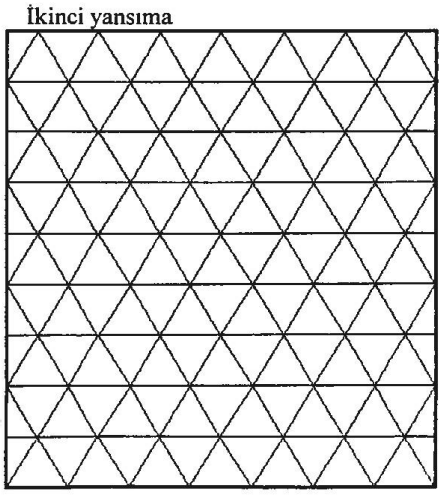
1- Verilen şekli örüntü bloklarını kullanarak oluşturunuz. Oluşturulan şekli önce 1 numaralı sonrada 2 numaralı çizgiye göre yansımasını bulunuz. Bulduğunuz şekilleri aşağıya çiziniz.



İlk yansıma

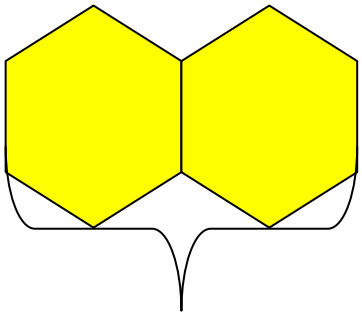


İkinci yansıma

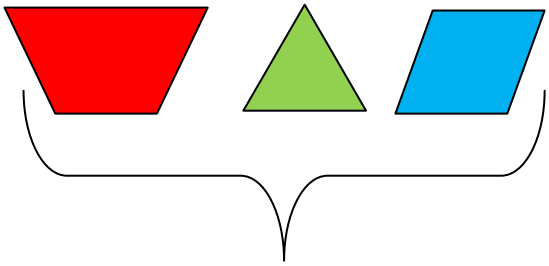


APPENDIX F

ACTIVITY for FRACTIONS by PATTERN BLOCKS



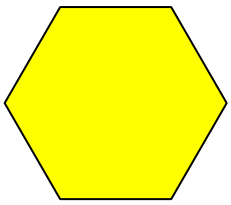
BÜTÜN

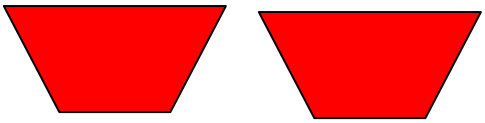


PARÇALAR

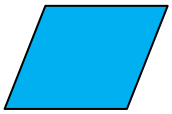
1. Aşağıdaki bloklar bütünün kaçta kaçıdır? Kesri boşluğa yazınız.

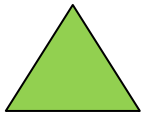
a) 1 sarı blok ---------- b) 2 kırmızı blok ----------



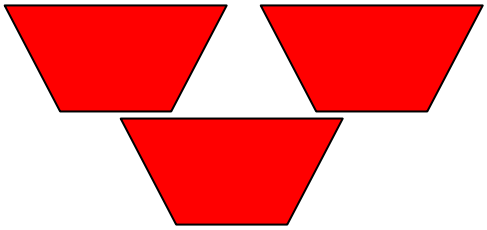


c) 1 mavi blok ---------- d) 1 yeşil blok ----------

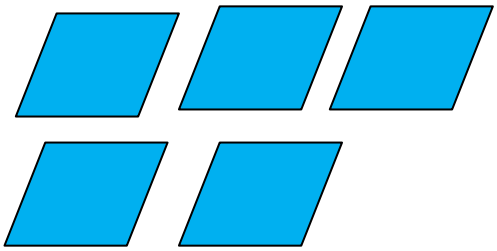


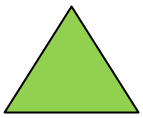


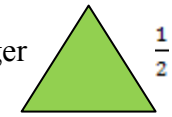
e) 3 kırmızı blok ----------

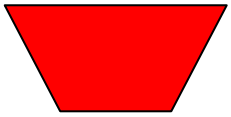
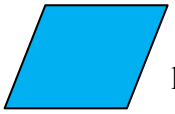


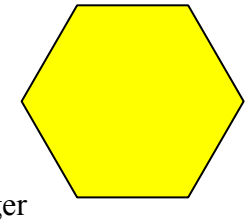
f) 5 mavi blok ----------



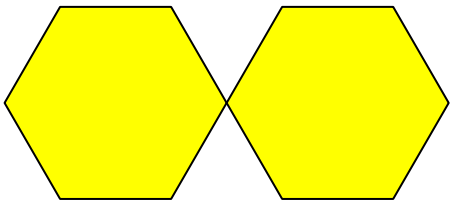
2. Eğer  $\frac{1}{2}$ birime eşit ise 1 birimi çiziniz.

3. Eğer  $\frac{1}{2}$ birime eşit ise $2\frac{1}{2}$ birimi çiziniz.

4. Eğer  1 birime eşit ise  kaç birimdir?



5. Eğer  1 birim ise kaç birimdir?



Eğer 1 bütün ise

6. $\frac{1}{2}$ nin $\frac{1}{2}$ si nedir?
7. $\frac{1}{2}$ nin $\frac{1}{3}$ ü nedir?
8. $\frac{1}{4}$ ün $\frac{1}{3}$ ü nedir?
9. Verilen soruları matematiksel ifade olarak yazınız. Yapılan işlemin kuralını yazınız.
10. Kesirlerde bölme işlemini materyali kullanarak açıklamaya çalışınız.

APPENDIX G

ACTIVITIES APPLIED BY TEACHERS

G-1. Fraction Bars

1- Elinizdeki modellerin hangi kesirleri gösterdiğini yazınız.
   a. Paydası aynı olan kesirler
      Payı aynı olan kesirler
2- Elinizdeki modelleri kullanarak kesirlerde sıralama yapınız. Nasıl yaptığınızı yazınız.
3- Paydası aynı olan iki kesir seçerek toplama işlemini elinizdeki materyali kullanarak yapmaya çalışınız. Nasıl yaptığınızı modelleyerek anlatınız.
4- Paydası farklı olan iki kesir seçerek toplama işlemini elinizdeki materyali kullanarak yapmaya çalışınız. Nasıl yaptığınızı modelleyerek anlatınız.
5- Kesirlerde çıkarma işlemini elinizdeki materyali kullanarak yapmaya çalışınız. Nasıl yaptığınızı modelleyerek anlatınız.
   ½ kesrinin ½ 'sini elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz.
6- ½ kesrinin ¼'ünü elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz.
7- Sorulan soruları matematiksel ifade olarak yazınız.
8- ¼ kesrinin ½ sini elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz. 7. Soru ile ilişkisini tartışarak görüşünüzü yazınız.
9- 1/ 2 kesrinin içinde kaç tane 1/2 kesri vardır? Elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz.
10- ½ kesrinin içinde kaç tane ¼ kesri vardır? Elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz.
11- Sorulan soruları matematiksel ifade olarak yazınız.
12- ¼ kesrinin içinde kaç tane ½ kesri vardır? Elinizdeki materyali kullanarak gösteriniz. Modelini çiziniz. 11. Soru ile ilişkisini tartışarak görüşünüzü yazınız.

APPENDIX G

G-2. Base-Ten Blocks

1-) Elinizdeki onluk taban bloklarını kullanarak aşağıda verilen ondalık kesirleri gösteriniz. Modellerini çiziniz.

a) 0,3

b) 1,02

c) 2,43

2-) Aşağıda verilen toplama işlemini onluk taban bloklarını kullanarak yapınız. Modelini çiziniz.

a) 1,42 + 2,08

3) Aşağıda verilen çıkarma işlemlerini onluk taban bloklarını kullanarak yapınız. Modellerini çiziniz.

a) 0,53 – 0,21

b) 1, 21 – 0,12

4) Aşağıda verilen çarpma işlemlerini onluk taban bloklarını kullanarak yapınız. Modelini çiziniz.

a) 2 × 0,4

b) 1,2 × 0,5

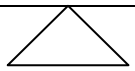
c) 1,3 × 2,4

d) 1,2 ×2,0

APPENDIX G

G-3. Geometry Sticks

1- Elinizdeki materyalde iki nokta arası 1 br'dir. Buna göre aşağıda uzunlukları verilen doğru parçaları ile üçgen elde etmeye çalışınız. Üçgenleri elde edip edemediğinizi yanlarına not alınız. Sizce neden ne olabilir?

	 Elde Edebildiniz mi?	
2 br, 5 br, 1 br		
2 br, 2 br, 5 br		
3 br, 4 br, 5 br		
2 br, 3 br, 5 br		
4 br, 5 br, 2 br		
1 br, 4 br, 3 br		

APPENDIX G

G-4. Geoboard

1- Elinizdeki materyali kullanarak çember oluşturunuz.
2- Çemberin orta noktasından geçen ve uç noktaları çember üzerinde olan doğru parçasını oluşturunuz.
3- Lastik ile içteki çemberi oluşturunuz. Diğer lastikleri kullanarak aşağıdaki doğru modellerini oluşturunuz:
    a. Çemberi kesmeyen
    b. Çemberi bir noktada kesen
    c. Çemberi iki noktada kesen
    d. Merkezden geçen ve çemberi iki noktada kesen
4- Lastik yardımıyla büyük çemberi oluşturunuz. Diğer lastikleri kullanarak istenilenleri modelleyiniz.
    a. Köşesi merkez üzerinde olan açı
    b. Çevre açı
    c. Çapı gören çevre açı
    d. Aynı yayı gören iki çevre açı
    e. Aynı yayı gören merkez ve çevre açı

CURRICULUM VITAE

Personal Information

Surname, Name: YILDIZ TUNCAY, Banu
Nationality: Turkish (T.C)
Dateand Place of Birth: 26.07.1977, Bursa
Marital Status : Married

Working Experience

➢ **17.04.2008-**	Central Finance and Contracts Unit, Coordinator
➢ **22.02.2006 – 17.04.2008**	Central Finance and Contracts Unit, Contract Manager
➢ **10.04.2003-21.02.2006**	Public Procurement Authority, Analyst
➢ **06.09.2001-09.04.2003**	Middle East Technical University, Elementary Mathematics Education, Research Assistant

Education

2004-2012	Middle East Technical University Ankara, TURKEY Ph.D Student, Dept. of Secondary Science and Mathematics Education
2001-2004	Middle East Technical University Ankara, TURKEY M. S, Dept. of Secondary Science and Mathematics Education Thesis Title: "Preservice Teachers Attitudes Toward The Use of Manipulatives: The Influence of Field Experience
1996-2000	Middle East Technical University Ankara, TURKEY B.S., Mathematics Education
1996-2001	Middle East Technical University Ankara, TURKEY B.S., Mathematics

Publications

YILDIZ, T.B. (2004) Preservice Teachers Attitudes Toward The Use of Manipulatives: The Influence of Field Experience. (Master Tezi, Orta Doğu Teknik Üniversitesi, 2004)

Çakıroğlu, E. ve Tuncay, B., "Turkish Pre-service Teachers' Views about Manipulative Use in Mathematics Teaching: The Role of Field Experience and Methods Course", The Enterprise of Education, ed. C. V. Sunal and K. Mutua, 275-289, Greenwich: Information Age Publishing, 2007.

Bulut, S. ve Yıldız, T. B. "Ortaöğretim Matematik Öğretmen Adaylarının Olasılıkla İlgili Kavram Yanılgılarının İncelenmesi", V. Ulusal Fen Bilimleri Ve Matematik Eğitimi Kongresi, 16-18 Eylül 2002: ODTÜ Kültür Ve Kongre Merkezi, Ankara.

İlköğretim Matematik 2 Ders ve Öğrenci Çalışma Kitabı, Doku Yayıncılık

Workshops

Çakıroğlu, E. ve Yıldız, T. B., "Somut Araçlarla Geometri Öğretimi:GeometriTahtası (Geotahta) ve Simetri Aynası ".V. Ulusal Fen Bilimleri Ve Matematik Eğitimi Kongresi, 16-18 Eylül 2002: ODTÜ Kültür Ve Kongre Merkezi, Ankara.

Bulut, S., Çömlekoğlu, G., Seçil, Ö., S., Yıldırım, H., H.ve Yıldız,T. B., "Matematik Öğretiminde Somut Materyal Kullanımı" V. Ulusal Fen Bilimleri Ve Matematik Eğitimi Kongresi, 16-18 Eylül 2002: ODTÜ Kültür Ve Kongre Merkezi, Ankara.

Certificates

Microsoft Certificate of Achievement, 2071: Querying Microsoft SQL Server 2000 with Transact –SQL

Microsoft Certificate of Achievement, 2072: Administering a Microsoft SQL Server 2000 Database

Microsoft Gold Certificate, Web Tabanlı (ASP) DB Uygulamaları Geliştirme 24 Ekim 2003