MIDDLE SCHOOL MATHEMATICS TEACHERS' PROBLEMS IN TEACHING TRANSFORMATIONAL GEOMETRY AND THEIR SUGGESSTIONS FOR THE SOLUTION OF THESE PROBLEMS

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

BY

SERAP İLASLAN

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

FEBRUARY 2013

Approval of the Graduate School of Social Sciences

Prof. Dr. Meliha ALTUNIŞIK
Director

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

Prof. Dr. Jale ÇAKIROĞLU
Head of Department

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

Prof. Dr. Safure BULUT Co-Supervisor	Assoc. Prof. Dr. Erdinç ÇAKIROĞLU Supervisor

Examining Committee Members

Assoc. Prof. Dr. Mine IŞIKSAL BOSTAN	(METU, ELE)	____________________
Assoc. Prof. Dr. Erdinç ÇAKIROĞLU	(METU, ELE)	____________________
Prof. Dr. Safure BULUT	(METU, SSME)	____________________
Assist. Prof. Dr. Çiğdem HASER	(METU, ELE)	____________________
Assist. Prof. Dr. Didem AKYÜZ	(METU, ELE)	____________________

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: Serap İLASLAN

Signature:

ABSTRACT

MIDDLE SCHOOL MATHEMATICS TEACHERS' PROBLEMS

IN TEACHING TRANSFORMATIONAL GEOMETRY

AND THEIR SUGGESTIONS FOR THE SOLUTIONS OF THESE PROBLEMS

İlaslan, Serap

M.S., Department of Elementary Science and Mathematics Education

Supervisor: Assoc. Prof. Dr. Erdinç ÇAKIROĞLU
Co-Supervisor: Prof. Dr. Safure BULUT

February 2013, 90 pages

The purpose of this study was to reveal and define the problems middle school mathematics teachers experienced in applying transformational geometry and the solutions they proposed to overcome these problems. A total of six elementary mathematics teachers (grades 5-8) in Ankara participated in the study. The data were collected by means of one-to-one interviews with the participants.

The findings indicated that the participants' problems divided into three parts. These problems were problems arising from teachers, problems arising from students and problems arising from resources. The participants expressed challenges in teaching due to lack of materials, textbooks, and visualization ability of teachers, classroom size, and time. According to the findings, rotation was the most problematic issue. The participants claimed insufficient technological materials were the reason of this problem. Participants did not feel confidence enough to implement transformational geometry especially in rotation since they lacked adequate training and support. The participants claimed that the Ministry's support should be increased, concrete and

technological materials should be sufficient in number, and the duration of transformational geometry lesson should be increased.

Keywords: Middle School Mathematics Teachers’ Problems, Transformational Geometry, Teachers’ Solutions

ÖZ

ORTAOKUL MATEMATİK ÖĞRETMENLERİNİN

DÖNÜŞÜM GEOMETRİSİ ÖĞRETİMİNDE YAŞADIKLARI PROBLEMLER

VE BU SORUNLARIN ÇÖZÜMÜ İÇİN ÖNERİLERİ

İlaslan, Serap

Yüksek Lisans, İlkögretim Fen ve Matematik Alanları Egitimi Bölümü

Tez Yöneticisi: Doc.Dr. Erdinç ÇAKIROĞLU

Ortak Tez Yöneticisi: Prof. Dr. Safure BULUT

Şubat 2013, 90 sayfa

Bu araştırmanın amacı, dönüşüm geometrisinin uygulanması sırasında orta okul matematik öğretmenlerinin yaşadığı problemleri ve bu problemleri çözme yollarını belirlemek ve betimlemektir. Ankara ilinde görev yapmakta olan toplam 6 ortaokul matematik öğretmeni çalışmaya katılmışlardır. Bu çalışmanın verileri katılımcılarla birebir görüşme yoluyla toplanmıştır.

Bulgular katılımcı ögretmenlerin problemlerinin üçe ayrıldığını göstermiştir. Bu problemler öğretmenden kaynaklanan sorunlar, öğrenciden kaynaklanan sorunlar ve kullanılan kaynaklardan oluşan sorunlar. Katılımcılar materyal eksikliği (özellikle teknolojik materyaller), ders kitabı yetersizligi, görselleştirme yetenegi eksikliği, fiziksel mekânların yetersizliği ve zaman yetersizliği sebebiyle öğretim sırasında zorlandıklarını ifade etmişlerdir. Araştırmanın bulgularına göre en çok sorun yaşanan konu dönme konusudur. Bu sorunun sebebinin sınıflardaki teknoloji eksikliği olduğunu ifade etmişlerdir. Ögretmenler dönüşüm geometrisinin uygulanması ile ilgili uygun eğitim ve destegi almadıkları için kendilerini dönüşüm geometrisini uygulama konusunda yeterli hissetmemişlerdir. Katılımcılar Bakanlığın desteğinin arttırılmasını, geometri materyallerinin yeterli sayıda olmasını, okullardaki fiziksel şartların iyileştirilmesini ve dönüşüm geometrisi ders saati sayısının arttırılmasını önermişlerdir.

Anahtar Kelimeler: Ortaokul Matematik Öğretmenlerinin Sorunları, Dönüşüm Geometrisi, Öğretmen Çözümleri

To My Family

ACKNOWLEDGMENTS

I would like to take this opportunity to thank several people who have provided their help and encouragement throughout this study.

First, I want to thank my thesis supervisors Assoc. Prof. Dr. Erdinç ÇAKIROĞLU and Prof. Dr. Safure BULUT for their wisdom, guidance, and belief in me. They always challenged me to do my best, and encouraged me in every step of my thesis. Thanks for their great efforts.

I am also thankful to Seher AVCU and Marriam KASSIMALİ for their help, support, encouragement, suggestions and comments. Without your close friendship, inspiration, help, suggestions and support, this thesis would not have been written. Thanks for being such good friend.

I am forever grateful to my mother, Sabiha İLASLAN, my father, İsrafil İLASLAN and my brothers Recep İLASLAN and İsmail İLASLAN for their support throughout my life.

I would also like to express my sincere gratitude to the teachers who participated to the study. Thank you all very much.

TABLE OF CONTENTS

PLAGIARISM..iii

ABSTRACT...iv

ÖZ...vi

DEDICATION...viii

ACKNOWLEDGMENTS..ix

TABLE OF CONTENTS...x

LIST OF TABLES...xiii

LIST OF ABBREVIATIONS..xiv

CHAPTER

1. INTRODUCTION..1

1.1 Research Questions...3

1.2 Significance of the Study...3

1.3 My Motivation for the Study..5

1.4 The definitions of Important Terms..5

2. LITERATURE REVIEW...7

2.1 Geometry Education...7

2.2 Transformational Geometry...9

2.3 Transformational Geometry in the Turkish Middle School Curriculum...11

2.4 Importance of Teacher Knowledge……………….................................14

2.5. Research Studies Related to Transformational Geometry.......................15

2.6. Research Studies Related to the 2005 Curriculum in Turkey……….......20

2.7. Research Studies Related to Mathematics Teachers' Knowledge and Their Qualifications……………………………..……………………..22

2.8 Summary of Literature Review……………….......................................23
3. METHOD...26
3.1 Design of the Study...26
3.2 Participants of the Study..27
3.3 Data Collection………………………..28
3.3.1 Interview Protocol...28
3.3.2 Data Collection Procedure...29
3.4 Data Analysis...30
3.5 Quality of the Study...32
3.6 Assumptions..33
3.7 Limitations...33
4. RESULTS...35
4.1 Issues about Teachers 35
4.1.1 Problems Arising from Teachers in Teaching Transformational Geometry...35
4.1.2 Reason and Solutions of Problems Arising from Teachers in Teaching Transformational Geometry………………..……………...…..........39
4.1.3 Suggestions Proposed by Teachers in Overcoming Problems Derived from Themselves in Teaching Transformational Geometry……………....41
4.2 Issues about Student 42
4.2.1 Problems Related to Students in Teaching Transformational Geometry………………………………………………………………...42
4.2.2 Reasons and Solutions of Problem Related to Students in Teaching Transformational Geometry……………………………………………..45

4.2.3 Participants' Suggestion for Overcoming Students' Problems in Teaching Transformational Geometry..47
4.3 Issues about Resources..48
4.3.1 Resource Originated Problems Experienced by Teachers in Teaching Transformational Geometry…………………………..……..…........48
4.3.2 Reasons and Solutions of the Resource Originated Problems Experienced by Teachers in Teaching Transformational Geometry............51
4.3.3 Further Suggestions of Teachers for Overcoming Resource Originated Problems Experienced in Teaching Transformational Geometry……..........52
5. DISCUSSION AND RECOMMENDATIONS...55
5.1 Discussion on the Teacher Issue..55
5.2 Discussion on the Student Issue..59
5.3 Discussion on the Resource Issue..60
5.4 Implications………………………...64
5.5 Recommendations for the Further Studies…………….........................66
5.6 Last Words……………………...67
REFERENCES..68
APPENDICES...81
A. APPENDIX Interview Protocol……..81
B. APPENDIX 5-8 Mathematic Curriculums……..84
C. APPENDIX Thesis Photocopy Permission Form……...............................90

LIST OF TABLES

TABLES

Table 3.2 Participants' Demographic Information…………..……...........................28

Table 3.4 Themes and Sub-themes of teachers' perceptions regarding issues and problems…………..……………………………………………….......................31

LIST OF ABBREVIATIONS

T	Participating Teachers
SBS	The National Examination Of Level Determination
MoNE	Ministry Of National Education
NCTM	National Council Of Teachers Of Mathematics

CHAPTER 1

INTRODUCTION

Geometry has an important place in human life, and individuals' development in mathematics is conceptualized under various subject areas (Baykul, 2002). Geometry is one of these areas which has an important role in school mathematics (Gürbüz, 2008). According to the standards of the National Council of Teacher of Mathematics in the USA (NCTM, 2000), geometry enhances the reasoning and proving skills of students. Students learn the relations among geometric shapes and their characteristics. Similarly, Ersoy (2003) stated that geometry is a natural environment in which students' reasoning and judgment abilities improve. In addition, Baykul (2005) stated that geometry is a learning area which has the potential to make students enjoy mathematics while learning.

In daily life, people have to solve many simple problems (such as frame-making, wall paper coating, paint making, making storage) and the solution of such problems requires basic geometric skills. For this reason, geometry is a broad subject taught at all grade levels of primary education (Altun, 2002). In addition, Pesen (2003) indicated that geometry is an important topic of elementary mathematics and it has an important place in learning mathematics. Geometry education is as important as that of other mathematics topics. In addition, it is one of the most frequently used tool in science and art (Pesen, 2003).

According to the standards of the National Council of Teachers of Mathematics (NCTM, 2000), students can identify, describe, compare, and classify geometric shapes. Toptas (2007) stated that students develop spatial intuition and discover the relationships between geometric shapes by building, drawing, measuring, visualizing, comparing and classifying. Similarly, geometry is a natural area in which students' reasoning, judgment skills and proving geometric theorems develop (Ersoy, 2003). For this reason, geometry is one of the key areas in the mathematics curriculum.

In Turkey, in order to educate qualified individuals, elementary school mathematics curriculum development study was started in 2003 by the Ministry of National Education (MoNE), the Board of Education at 2003As part of these changes; some topics were added to the geometry content area. Transformational geometry is one of these newly added topics. According to Ersoy and Duatepe (2003) the transformation topic in geometry is rather enjoyable for children and bears some features that can promote their creative thinking. For example, a rug pattern which is repetitive, shifted, or rotated, will help them to become aware of the geometry around them.

Ball (1990) argued that qualified teachers are required so that geometry can be taught at the desired level and a variety of educational environments can be established. In addition, for a teacher to teach geometry at the desired level, they should know the topic in depth. Teachers' lack of knowledge has a negative impact on students' learning (Ball, 1990).

Aydın (2000) maintained that the three fundamental elements of education, which is regarded as a social system, are considered to be the student, the teacher and educational programs. He claimed that each of these elements is important and that they are interrelated. He postulated that among these elements, the notion that the teacher has the highest impact on the other elements, and thus on the system, maintains its reality. Prior research indicate that, both students and instructors have difficulties in understanding the transformation topic since this is a little more abstract than the other topics (Harper, 2002). Therefore, in this research, the significance of teachers in the teaching transformational geometry and the problems they encounter in teaching this topic will be examined. More specifically, middle school mathematics teachers' problems regarding transformational geometry and ways to overcome these problems will be analyzed.

1.1. Research Questions

The specific research questions addressed in this study were:

1. What are the problems that middle school mathematics teachers experience for the teaching of transformation geometry?
2. In what ways do middle school mathematics teachers' overcome the difficulties they experience about teaching transformational geometry?
3. What are the suggestions of middle school mathematics teachers for overcoming the problems in teaching transformation geometry?

1.2. Significance of the Study

Pleet (1990) asserted that geometry is considered to provide an opportunity to develop spatial-visual ability; thus, it is an important subject. Accordingly, while teaching spatial visual skills, especially the study of transformation geometry concepts may have an important role (Pleet, 1990). However, the literature related to transformational geometry is limited in Turkey. The middle school level educational aspect of transformational geometry has not been studied comprehensively since it is a new topic in middle school education in Turkey, which is why this study is of significance.

The transformational geometry in the curricula of primary school mathematics and secondary school geometry is a new topic for most of the Turkish mathematics teachers. Since transformational geometry is a new topic, mathematics teachers are experiencing problems in this topic (Keleş, 2009). Literature showed that both students and instructors have difficulties in understanding the transformation geometry since this is a little more abstract than the other topics (Harper, 2002). The fact that the topic is new and teachers are experiencing problems in this topic makes this study significant. In this study, a problem of middle school teachers about transformational geometry which is one of the newly added topics is examined.

According to Desmond (1997), Edwards and Zazkis (1993), and Law (1991), both students and teachers have difficulties in understanding the reflection, rotation, and translation notions. The success of the education system is associated with teachers' qualifications (İşler, 2008). In order to educate qualified teachers, it is important to identify the problems faced by teachers. In addition, investigating the problems of middle school mathematics teachers' problems about transformational geometry will provide information to managers and teachers. Resolving the deficiencies and problems will be an important step in achieving the objectives of mathematics education.

This study can be of significant contribution to the renewal of the curriculum of the National Education Ministry and to teacher educators in training mathematics teachers. Furthermore, transformational geometry is not just a topic among the mathematics topics but also contributes to the development of students' spatial skills. There is a correlation between spatial visualization ability and students achievement (Kirby and Boulter, 1999). For this reason, transformational geometry and the problems experienced in this topic is one of the important topics that needs to be investigated.

In addition, teachers' content knowledge and pedagogical content knowledge increases students' level of success and their contribution to instruction (Shulman, 1986). Because teachers with content knowledge and pedagogical knowledge implement more effective lessons, their students are more successful and, thus, the problems they experience during instruction are minimal (Shulman, 1986; Wilson, 1987). Consequently, by determining the problems of teachers, this study will be of contribution to the Ministry of Education. Furthermore, this study is significant as it will suggest ways to overcome the problems experienced by teachers and draw attention to these problems.

Overall, investigating teachers' problems might contribute to the improvement of geometry instruction and the content of in-service training. It might also help teachers in finding solutions for the problems they face during the implementation of transformation geometry. Most of the studies in Turkey regarding implementation were conducted on students. These studies do not give in-depth information about teachers' problems of transformation geometry and teachers' problems about implementation of transformational geometry.

1.3. My Motivation for the Study

I graduated from Middle East Technical University in 2009 and I have been working as a mathematics teacher for four years. When I started four years ago to teach transformational geometry, I faced several difficulties. This topic did not make sense to the students and it was not easy for them to understand transformational geometry. Moreover, when I spoke with different mathematics teachers, I saw that they faced the same difficulties about this topic. Most teachers do not know how to teach this topic. Teachers only give the information which textbooks present and give not more than two examples during the lesson.

In my opinion, this subject is a difficult and an abstract subject for students. It is believed that such a subject is useful to study since it is new and has significant role in the middle school curriculum. In addition to these, two of the questions that I asked myself are "How can I teach this topic better?", and "What do I need in order to better teach this topic?" I will attempt to suggest an alternative way to the reader.

Lastly, I have decided on this topic because I want to make a study which has not been studied on much and will be beneficial for teachers. I believe that this study will make contribution to my profession as a teacher.

1.4. Definitions of Important Terms

Attitude: A learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation or concept(Aiken, 1970, p.551).

Middle School Mathematics Teachers: Teachers who teach mathematics in the upper primary level, between 5th and 8th grades, are referred to as middle school mathematics teachers in the study.

Transformational geometry: A subset of geometry in which students learn to identify and illustrate movement of shapes (Boulter & Kirby, 1999, p.285).

Visualization ability: The ability of mentally manipulate, rotate, twist, or invert a pictorially presented stimulus object (McGee, 1979, p. 893).

CHAPTER 2

LITERATURE REVIEW

In this chapter, several studies on transformational geometry and issues related to its curriculum and teaching is reviewed. Most of these studies are related to the instructional practices of transformational geometry. In addition, studies related to elementary mathematics curriculum and teachers' qualifications are summarized. Since the number of studies on the teaching of transformational geometry in Turkey is limited, most of the reviewed studies were conducted in other countries.

2.1 Geometry Education

"The word geometry is Greek for geos - meaning earth and metron - meaning measure" And since it is about the education of children, it is grasping the space in which the child lives, breathes and moves, the space that the child must learn to know, explore, conquer, in order to live, breathe and move better in it (Freudenthal, 1973).

Develi and Orbay (2003) mentioned that the primary inspiration sources of mathematics phenomenon are life and nature. Apart from using geometry to solve problems in other areas of mathematics, it is also important because it is used to solve problems in daily life and in other disciplines such as sciences and arts (Toptas, 2007). Geometry as an area in mathematics has a vital role in education; therefore, it is worth being investigated (Turgut & Yılmaz, 2007).

Besides, Binbaşıoğlu (1981) stated that geometry is not only a learning area of mathematics but it is also a subject that we come across in daily life. Geometry is the first issue that attracts the attention of people. For this reason, geometry is important for human's life (Binbaşıoğlu, 1981). According to Fidan (1986), geometry topics first gained attention of people because of the necessity of to break down a surface piece correctly. This caused the emergence of geometry which enables human beings to the measure objects and shapes and also to describe these numerically. Hence, geometry has an important role in human beings' lives.

In addition, Hacısalihoglu, Mirasyedioglu and Akpınar (2004) argued that students should learn accurate definitions in geometry. They should be able to develop the ability to identify shapes based on visualization, drawing, measuring and construction. Otherwise, they will memorize definitions and an accompanying example. According to NCTM (1998), establishing relationships among the school geometry and the real-world experiences makes it easier for students to improve required mathematics abilities and achievement in geometry.

Olkun and Toluk (2003) claimed that geometry not only deals with concrete objects and shapes but also contributes to learning of mathematics. However, it should be addressed from an early age. They argue that students begin to develop abstract concept thinking at elementary education level. Up to elementary education level, students begin to develop abstract concepts thinking system. In order to contribute this process, geometry teaching is very important at elementary school years (Olkun and Toluk, 2003).

As stated above, teaching elementary school geometry topics is as important as teaching other topics (Turgut & Yılmaz, 2007). Therefore, students' understanding of geometry is also important. Ding and Jones (2006) stated that, in the Van Hiele model, the development of students' thinking in geometry directly depends on the form of instruction received. Thus, Gürbüz (2008) mentioned that teachers are the basic elements of the education system, so the role of the teacher is significant while teaching geometry and developing students' geometric thinking to the required level.

2.2. Transformational Geometry

Transformation geometry topic as a sub learning area of geometry and the importance of geometry are examined. The study of transformational geometry as a topic in middle school consists of transformations such as translation, reflection and rotation (Karakuş, 2008; Pleet, 1990).

The properties of geometric objects and properties of transformations should not be thought independently of each other (Bouckaert, 1995). Transformational geometry links the properties of transformations to the properties of objects and it can be characterized as the study of geometric objects in the plane. Also, the properties of transformations enables one to discover and prove the properties of geometric objects, to form patterns like friezes, rosettes, and wallpapers, to classify geometric objects, and perceive the chirality of an object (as cited in Bouckaert, 1995). According to Gürbüz (2008), while learning transformational geometry, students should be able to construct patterns by using equal polygonal regions. Students discover the relationship among geometric shapes by constructing, drawing, measuring, visualizing, comparing, changing the shapes and classifying them and they develop spatial intuition (Gürbüz, 2008).

In addition, Ersoy and Duatepe (2003) stated that geometric shapes may need to be transformed from one position to another. Transformational geometry is a rather enjoyable activity for students. They stated transformational geometry develop students' creativity. Students can establish a connection between mathematics and art by means of experiences, knowledge and skills. Besides, they can understand how mathematics is important in both daily life and work life. For example, a rug pattern which is repetitive, shifted, rotated, will help them to realize the geometry around them (Ersoy and Duatepe, 2003).

Similar to Ersoy and Duatepe(2003), Knuchel (2004) added that for elementary school students, learning symmetry, as a sub learning area of transformational geometry, enables them to understand what is around them in a different context and create their own patterns. Moreover, she mentioned that life and mathematics are brought together in a concrete and meaningful way with this area of geometry. It is important for students to comprehend the concepts of geometry and symmetry in the way that makes them think that everything they see around them has a strong foundation in mathematics, even if it is not directly related to it.

According to Hollebrands (2003), there are three important reasons why students should study geometric transformations in school mathematics: it provides students with opportunities to think about important mathematical concepts (e.g., symmetry), it provides students with a context within which they can view mathematics as an interconnected discipline, and it provides them with opportunities to engage in higher-level reasoning activities using a variety of representations.

Similar to Hollebrands (2003), Peterson (1973) pointed out that transformational geometry encourages students to investigate geometric ideas by means of an informal and intuitive approach. This approach stresses sensitivity, conjecturing, transformation and inquisitiveness. Transformation can lead students to explore abstract mathematical concepts of congruence, symmetry, similarity, and parallelism, enrich students' geometrical experiences, thoughts and imagination, and thereby enhance their spatial abilities.

Research suggests that students should have sufficient knowledge in geometric transformations by the end of eighth grade in order to be successful in higher level mathematics (Carraher & Schlieman, 2007; NCTM, 2000). However, studies showed that students have difficulties in understanding the concepts and variations in performing and identifying transformations including translation, reflection, rotation and combinations of transformations of these types (Clements & Burns, 2000; Edwards, 1990; Olson, Zenigami & Okazaki, 2008; Rollick, 2009). For example, Edwards (1989) found that elementary school students encounter difficulties in both executing and identifying transformations. In these studies, it was concluded that while most students have an operational understanding of transformations, most have not developed a conceptual understanding. According to Olkun and Toluk (2003), in order for the student to understand the topic, activities have to be carried out with both concrete materials and pictures (Olkun and Toluk, 2003).

As mentioned above, transformational geometry is of great importance. However, both students and teachers have difficulties in understanding transformational geometry. Transformational geometry is a subject that has only recently included in the Turkish school mathematics. Even though teachers experience difficulty in this subject, the number of studies carried out on this subject is not adequate. It is for this reason why this thesis is based on this subject.

2.3. Transformational Geometry in the Turkish Middle School Curriculum

As a result of dramatic changes in mathematics education around the world, in Turkey, both elementary and secondary school mathematics curricula have changed in 2005. Previous curricula included a heavy emphasis on set of facts, formulas and procedures. The current curricula focus on the processes of exploration, communication and conceptualization through classroom activities rather than presenting only facts in traditional ways. One of the aims of the curricula was to establish inquiry based mathematics education. In contrast with traditional classroom activities that emphasize repetition, practice, and other routine means to reach some focused endpoint, inquiry based mathematics instruction emphasizes student engagement in situated mathematical problem-solving (Güven et al., 2009).

The current elementary mathematics curriculum based on the principal of “every child can learn mathematics” (MoNE, 2009a). The mathematics curriculum grades from 1 through 8 requires to form an educational atmosphere where the student is mentally and physically involved (MoNE, 2009a; 2009b). They also emphasize skill development such as problem solving, connection, reasoning, communication, spatial visualization, psychomotor skills. The curricula demand that students understand the relationship between geometry and art, to develop aesthetic feelings and to develop positive attitude toward mathematics. Transformation geometry can have an influence on reaching these aims and skills.

There have been significant changes in the scope of geometry concepts, as well as in other areas. Bulut (2004) mentioned about some of these changes. One of them is relating content and process to students' life. More specifically, utilizing teaching methods and techniques which provide students with mental and physical activation, using equipment and concrete models facilitating meaningful learning of mathematics, teaching the meanings of the rules instead of having students memorizing them, using activities which help students to see how the mathematics works around them, in other courses or real life. Developing spatial skills and a feeling of aesthetics is also taken into consideration in the new curriculum (Bulut, 2004).

The Turkish elementary school mathematics curriculum guide for the first five grades presents the structure of transformational geometry instruction as follows:

> *Symmetry as a sub-learning domain of mathematics is placed into the math curriculum as of 2nd grade by pursuing a certain development. To differentiate symmetry and the axis of symmetry, an appropriate learning environment should be provided to the students where concrete models accompanied with folding and cutting activities are utilized. In the 4th grade, geometric shapes that have more than one axis of symmetry is to be handled for a certain period of time until the students have reached a certain level.* (MoNE 2004, p.29)

As can be seen, the basics of transformational geometry are included in the curricula of 1st to 5th grade elementary mathematics. The curricula of 5th to 8th grade mathematics consist of five basic strands: Numbers, Geometry, Measurement, Probability and statistics, and Algebra. In the geometry strand, concepts of transformational geometry are taught formally and in detail from the fifth through eighth grades.

In this context, The learning outcomes of grade five transformational geometry are as follows: students should be able to determine and draw the symmetry lines of polygons, draw the symmetry of a plane shape according to a given symmetry line, make the tesselations by means of regular polygonal regions (MoNE, 2009a).

The learning outcomes of sixth grade about transformational geometry are as follows: Students should be able to explain the translation movement, draws the figure resulting from a shape's translation, make patterns by means of congruent and similar polygons and polygonal regions and make the tessellations by means of translation (MoNE, 2009b).

The learning outcomes of seventh grade about transformational geometry are as follows: students should be able to explain reflection, explain the rotation movement, draws shapes by rotating them around one point according to a specified angle, make the tessellations by filling a space with polygonal region models, specifies the codes in the tessellations formed with regular polygonal region models, and make the tessellations by means of reflection, translation and rotation (MoNE, 2009b).

The learning outcomes of eighth grade about transformational geometry are as follows: Students should be able to make reflection in a coordinate plane according to one of the axes, specifies and draw figures by translating a shape along any line and by rotating around the origin, determine the symmetry of geometrical objects, specify and draw glide reflection of shapes (MoNE, 2009b).

As can be seen, students learn the basic transformations formally between the fifth through eighth grades. Moreover, transformation geometry takes place in the current secondary school geometry curricula in an extended form (MoNE, 2009c; 2010; 2011) so that students should have strong background on this topic in elementary school. Therefore the problems in elementary school should be determined and overcome them before high school.

Parallel to the changes in teacher roles in curricula, research has focused on the importance of mathematics teachers. The 2004 curriculum began to be officially implemented in the 2005-2006 academic year throughout Turkish schools and teachers played an important role in this process since they are the stakeholders whose understanding of the curriculum has direct consequences in student learning (İşler, 2008). As mentioned earlier, owing to the importance of teachers as implementers of the curriculum, the difficulties teachers experience in transformational geometry added as a new topic to the curriculum is the subject of this thesis.

2.4. Importance of Teacher Knowledge

> *"Teachers need not only understand that something is so; the teacher must further understand why it is so."(*Shulman, 1986; p.9)

One of the most widely offered explanations of why students do not learn mathematics is the inadequacy of their teachers' knowledge of mathematics. Knowledge of mathematics is obviously fundamental to being able to help someone else learn it (Ball, 1988). What teachers need to know was considered as research content by many researchers and they have similar or extended ideas. Although there is no contradiction in whether teachers should learn mathematics conceptually, or teachers need to understand mathematics in order to teach it. Frameworks on teachers' knowledge are critical to better understand how teachers need to be educated. One of the prominent concepts of teacher's knowledge was brought up by Shulman (1986).

Shulman proposed three categories of teacher subject matter knowledge. His first category, content knowledge, was intended to denote "the amount and organization of knowledge... in mind of teachers" (p.9). Content knowledge, according to Shulman, included both facts and concepts in a domain but also why facts and concepts are true and how knowledge is generated and structured in the discipline (Bruner, 1960; Schwab, 1961/1978).

The second category advanced by Shulman and his colleagues (Shulman, 1986; Wilson et al., 1987) was pedagogical content knowledge. With this category, he went "beyond knowledge of subject matter per se to the dimension of subject matter knowledge" for teaching (Shulman, 1986). The concept of pedagogical content knowledge attracted the attention and interest of researchers and teacher educators alike. Component of pedagogical content knowledge, according to Shulman (1986), are representations of specific content ideas, as well as an understanding of what makes the learning of a specific topic difficult or easy for students. Shulman's third category is curriculum knowledge. Involves awareness of how topics are arranged both within a school year and over time and ways of using curriculum resources, such as textbooks, to organize a program of study for students.

Shulman and colleagues' work expanded ideas about how knowledge might matter to teaching, suggesting that it is not only knowledge of content but also knowledge of how to teach content that influences teachers' effectiveness. Within a given context, teachers' knowledge of content interacts with knowledge of pedagogy and knowledge of curriculum to create a unique set of knowledge that drives classroom behavior.

2.5. Research Studies Related to Transformational Geometry

As stated earlier, transformational geometry was added to the mathematics curriculum in 2005 in Turkey. Thus, there are few studies on the teaching of this topic to middle school students. First those studies conducted abroad and then the ones carried out in Turkey will be explained.

Suydam (1985) mentioned that the spatial visual aspect becomes as important as the logical-deductive aspect with the help of transformations. For example, Boulter (1992) discussed in his study that people who have great spatial ability perform better in transformational geometry as the tasks require making mental rotations. For instance, in their experimental study Hoong and Khoh (2003) investigated the effects of different instructional approaches with geometers' sketchpad on students' spatial abilities and their conceptual understanding and mapping within the transformation geometry topic. Independent from the pedagogy, in the classes which were instructed by the teachers who had the knowledge of using geometers' sketchpad on transformation geometry, showed more success than the other classes.

In any other study, Polwolsky (2006) used 8th grade students in her study. The study aimed to show students' understanding of transformations by designing tessellations like Gürbüz (2008). At the end of the study, students' knowledge of transformation was developed. In addition, students had a strong rotational understanding of symmetry and reflection. That students gained an understanding of transformational geometry was a finding of the study.

Furthermore, Zembat (2007) examined the teaching of reflection to elementary school students. Some activities were developed on paper. The activities were applied during the two-week period of 8 lessons and each lesson lasted 45 minutes. This study was analyzed by means of qualitative methods. During the analysis, some observations were made that students learned transformation and reflection, and that they needed to have pre-requisite information about measurement and projection.

Several research studies have been conducted on the teaching techniques of transformational geometry convenient for the class structure on account of the difficulties experienced. For example, Edwards (1997) stated that using micro world made it easier to construct a set of discernment and expectations related to the motion of geometric transformations.

Some researchers (e.g. Soon, 1989) have seen dynamic representations as a powerful tool to improve students' understanding of operational to conceptual thinking. Soon (1989) carried out a research at an elementary school in Singapore. He explained the importance of Van Hiele theory for students to understand the concepts of transformational geometry at a higher level. A series of proposals were put forth in this study; they strongly advocated the dynamic approach for teaching and learning transformational geometry.

Similar to Soon's (1989) study, Olive (2000) investigated the effect of dynamic geometry technology on teaching and learning geometry at different stages of education. In the study, geometry sketchpad was used at the elementary school to investigate how students would learn and how geometry would be taught, for instance with which material. In this way, the researcher observed that students understood better when they used dynamic geometry materials.

In a study by Glass (2001), entitled "Students' Reification of Geometric Transformations in the Presence of Multiple Dynamically Linked Representations", Glass aimed to make transformational geometry meaningful by defining it within a dynamic environment. At the end of the study, Glass found that the students participating in the study made sense of and configured first translation, then reflection and finally rotation. It was stated that students knew that the shape and the corner points of its symmetry were at an equal distance to the symmetry line. Furthermore, it was observed that an environment with dynamically linked representations made it easier for students to learn reflection.

In another study by Dixon (1997), entitled "The computer usage to formation of the reflection and rotation concepts", 241 8^{th} grade students created concepts of reflection and rotation by using dynamic geometry software. As a result of the research, it was found that students could made sense of and visualize these concepts better when they used dynamic geometry software. Contrarily, according to the results of Boulter' s (1992) study, there was not a significant difference between the experimental group who received object manipulation and visualization instruction and the control group who received traditional textbook-based instruction.

In another research, Gürbüz (2008) aimed to determine the elementary school teachers' qualifications on the sub learning strands like transformational geometry, geometric objects, patterns and tessellations as well. Firstly, it was found that participant teachers were better at the sub learning strand called transformational geometry (79%) than the other sub learning strands such as geometric objects (56%), patterns and tessellations

(56%). On the topics of reflection (84%) and translation (84%) they had the same qualification rate, unlike the rotation topic (68%), which was lower. As for gender difference, female primary school teachers (57%) surpassed their male counterparts (33%) on the sub learning strands such as transformational geometry, geometric objects, pattern and tessellations.

One other study was conducted by Akay (2011). In the study, he/she investigated the impact of the peer instruction method on the success of 8th grade students in transformational geometry and their attitude toward mathematics. The study was conducted during the 209-2010 academic year. The sample was comprised of 112 8th grade students of a public school in Küçükçekmeçe, İstanbul. One of the two classes that the researcher was teaching was randomly assigned as the experimental and the other as the control group. The students in the experimental group received instruction in transformational geometry by means of the peer instruction method, while those in the control group received instruction in the traditional method. At the end of the study, it was found that the peer instruction method had a positive impact on students' success in transformational geometry and their attitude toward mathematics.

Differently, Yazlık (2011) conducted a study to investigate whether geometry instruction using the Cabri Geometry Plus II software had any impact on 7th grade students' learning outcomes in the topic of rotation geometry in math education and to examine students' attitudes toward the Cabri Geometry Plus II software. This study was carried out during the 2010-2011 academic year with 7th grade students. Over a period of six class lessons, the rotation geometry topic was taught by using the Cabri Geometry Plus II software in the experimental group comprised of 66 students, and in the traditional way in the control group comprised of 69 students. At the end of the study, it was found that utilizing the dynamic geometry software program Cabri in teaching rotation geometry had increased the success level of the students. In addition, according to the results of the survey on the experimental group students' attitude toward the Cabri program, it was found that the Cabri program enabled students in the experimental group to learn transformational geometry more effectively and permanently. The experimental group students recommended the Cabri program to the primary school students. They stated that the Cabri program increased their motivation to solve problems and that they could use this program in their self-studies in other subjects. Overall, it was found that the experimental group students had a positive attitude toward the Cabri program.

Similar to the study of Yazlık (2011), Karakuş (2008) defined the impact of computer assisted education on students' understanding in the topic of transformation geometry. The research was an experiment study comprised of a pre- and post-test and a control group. First, the software was introduced to the classes selected and assigned as the experimental groups, then computer assisted teaching of transformational geometry was implemented. In the control group, on the other hand, a task-based teaching model was used, as defined in the curriculum. At the end of the intervention, all the groups were administered a post-test. At the end of the study, when all the student scores were examined, a significant difference was found in favor of the experimental group in transformation geometry instruction. Furthermore, when the average scores of different topics were examined, it was found that while the average scores in the topics of reflection and rotation were higher in the experimental group, the average scores in the topic of translation were higher in the control group.

As it can be seen above, transformation geometry topic has not been studied substantially in Turkey; in other words, there are a limited number of research studies on this topic. In this respect, the current study aims to provide a detailed documentation for this research area where few studies have been conducted.

2.6. Research Studies Related to the 2005 Mathematics Curriculum in Turkey

In order to keep up with these developments and not to fall behind changes, the education in Turkey also underwent changes. A radical change in the primary school education was made by the Ministry of Education (MoNE) and new programs started to be implemented as of 2005.

Accordingly, in the new elementary mathematics curriculum, some subjects were added, while some of them were removed. For instance, in grades 1 to 5, the newly added subjects were patterns, tessellations, transformational geometry, probability, estimation, and object graph (MoNE, 2005). In the new curriculum of grades 6 to 8, the topics of estimation, patterns, tessellations, transformational geometry, fractals, perspective, some subjects related to statistics and probability, and some concrete models were added (MoNE, 2006). In this way, the idea that mathematics was a sum of knowledge and skills that needed to be learned in a more meaningful way was tried to be given (Hatay, 2007).

In the current study, the problems experienced by teachers regarding the instruction of transformational geometry were examined. Since it was believed that the other newly added topics and problems related to them had some kind of a relation to the topic of this study, studies conducted on the other topics added to the curriculum in 2005 have also been explained below.

In a study by Keleş (2009), the participating teachers expressed positive views about the newly added subjects into the curriculum, such as patterns, transformational geometry, estimation, symmetry, tessellations and statistics. Teachers stated that the newly added subjects developed students’ visualization skills and mathematical intelligence, and they were enjoyable, beneficial, and interesting for the teachers. One important emphasis was given to the connection between the newly added subjects and real life examples. Teachers in this study claimed that the new curriculum also taught them a new mathematics and they had a chance to learn more about the content by implementing the activities. Therefore, teachers' views in this study showed that newly added topics in the mathematics curriculum helped teachers enhance their knowledge. Similarly in Bulut's (2007) study, fifth grade elementary teachers stated that the newly added topics enhanced the curriculum.

Different from the findings of Bulut's (2007) study, Keleş, Haser and Koç (2012) found that the new curriculum into which new topics were added was believed by the teachers to be too loaded. This made teachers experience problems in time management. This study showed that the lack in students' knowledge in previous topics coupled with the loaded new curriculum had a negative impact on the implementation of the new curriculum by the middle school mathematics teachers. These findings regarding mathematics teachers support the findings of previous studies (Erbaş & Ulubay, 2008).

In addition, in a study by Özen (2006), it was found, based on the teachers' responses to questions regarding the 2005 primary school mathematics curriculum that the topics and activities added to the curriculum facilitated learning in mathematics. Also, Özdaş, Tanışlı, Köse and Kılıç (2005) examined the mathematics curriculum from the points of view of objectives, content, teaching-learning process, convenience and coherence of evaluation methods, and the probable problems. In their study, they utilized teachers' views using the qualitative method. 20 volunteers were selected out of 100 primary school teachers who participated in a seminar about the new curricula for primary schools. The data were obtained by using the semi-structured interview method and analyzed the data using the descriptive analysis method. According to the findings, most of the primary school teachers had a positive view on the new Mathematics Curriculum with respect to its objectives, content (including the newly added topics), the learning-teaching process and evaluation characteristics, but as for the implementation of the curriculum, there were similar opinions with respect to the existence of some problems regarding teachers, and the teaching environment.

As well as, Orbeyi (2007) studied teachers' opinions about the implementation of the new elementary mathematics curriculum for 1st-5th grades and evaluated the program based on these opinions. For this reason, she developed a survey related to acquirements, content, teaching-learning process and evaluation components of the new curriculum. The survey was applied to 459 elementary school teachers working in Çanakkale, Edirne and Eskişehir. Based on the research results, teachers found the acquirements, content (include newly added topics) and teaching-learning process components of the new curriculum sufficient.

2.7. Research Studies Related to Mathematics Teachers' Knowledge and Their Qualifications

The teaching profession and competencies issues emerge frequently not only in Turkey but also in many countries of the world. In the current study, the problems faced by mathematics teachers were investigated. Studies on teachers that are believed to have some relation to this study are explained below.

Kavak (1986) examined "self-assessment of teachers" and "students' assessment of teachers' approaches." According to the results obtained from the participating teachers, they often rated their level of satisfaction as "partially satisfactory" or "unsatisfactory". Similarly, Şahin (2006) investigated the level of qualifications of primary school teachers and whether there was a difference between teachers' own perceptions and those of the school administrators. According to the results of the research, female teachers perceived themselves more sufficient than male teachers. In addition, it was found that teachers needed in-service training in the usage of technological facilities, in testing and evaluation and guidance.

In contrast to Kavak (1986), Gözütok and others (2005), who evaluated 2004-2005 elementary education curricula in terms of teachers' qualifications, found that teachers had a high level of perceived competence of themselves and, because of this, they did not need feel the need for training. Moreover, teachers thought that a two-week in-service program given by the Ministry was sufficient for teachers.

Finally, Shulman (1986) sought answers to the following questions: “What do teachers need to know? What do teachers need in order to teach the lesson?” He revealed a new model by using the responses to these questions. He produced this model by using information which the teachers needed to know. According to the research results, teachers’ information models were restructured in the form of “content knowledge, curriculum knowledge and pedagogical content knowledge”. In the study, they found that 68% of pre-service teachers considered themselves sufficiently competent in teaching mathematics. However, it was highlighted by the researchers that almost a third of the pre-service teachers had stated that they did not regard themselves competent enough to teach mathematics.

Teachers are the basic elements of the education system, so the role of the teacher is significant while teaching geometry and developing students’ geometric thinking at the required level (Gürbüz, 2008). In this sense, the current study aims to provide a detailed documentation for the research areas where few studies have been conducted.

2.8. Summary of Literature Review

To sum up, the importance of geometry in middle school education cannot be denied. Transformational geometry as a sub-branch of geometry is placed in the curriculum and it is really a beneficial topic for enabling students to interpret the phenomena around them.

As can be seen in the above literature review, in most of the studies, researchers analyzed students’ problems regarding transformational geometry and technology usage in transformational geometry. A majority of the studies have dwelled on the impact of using dynamic software in transformational geometry instruction upon students’ learning performance and level of success (Hoong and Khoh, 2003; Soon, 1989; Olive, 2001; Glass, 2001; Dixon, 1997; Yazlık, 2011; Karakuş, 2008). In literature, no study on the problems teachers experience in relation to transformational geometry was encountered. Mathematics teachers’ problems as regards transformational geometry are one of the important factors to be investigated in teaching and learning mathematics. Owing to the need for investigation in this area, the current study aimed to define the problems experienced by middle school mathematics teachers regarding transformational geometry and the solutions teachers propose to overcome these problems.

There are studies in literature on the renewed 2005 curriculum and the topics newly added to it (Keleş, 2009; Keleş, Haser, Koç, 2012; Özen, 2006; Özdaş, Tanışlı, Köse and Kılıç, 2005; Orbeyi, 2007). However, as mentioned earlier, no study in literature investigated the problems teachers face while teaching specifically these newly added topics. Only the changes regarding the addition and removal of topics were described superficially (Keleş, 2009). In this study, however, to fill the gap in literature in this sense, transformational geometry, which is one of the newly added topics, was examined thoroughly and in more detail.

Teachers have a crucial role in the education system. As can be understood from related literature, there are some studies that were conducted on teachers' problems and proficiencies (Kavak, 1986; Sahin, 2006; Gözütok et al., 2005; Shulman, 1986). However, studies specifically on problems middle school mathematics teachers' experience have not been encountered. Only Gürbüz (2008) conducted a study on mathematics teachers' proficiencies but in this study only the characteristics of an effective teacher were listed. The problems teachers experience were not examined. In this study, the problems middle school mathematics teachers face and what they do to overcome these problems have been examined in detail.

As a result, as understood from the studies in literature, some studies were conducted on mathematics teachers, though not in abundance, some studies on the newly added topics exist, transformational geometry was studied but no study was carried out on the problems middle school mathematics teachers experienced in relation to transformational geometry. For this reason, in this study the problems middle school mathematics teachers experience while teaching transformational geometry and the solutions they have come up with to overcome these problems have been examined in detail.

CHAPTER 3

METHOD

In this chapter, the method of inquiry is explained in detail. Design and participants of the study, methods and procedures used to gather and analyze data, issues of the quality, and the limitations of the study are described.

3.1. Design of the Study

As stated earlier, one of the main goals of the study was to produce a detailed description of the problems that teachers experience when teaching transformational geometry based on their own views. In order to reach this aim, qualitative data collection techniques, mainly interviews, were used.

Qualitative methods help researchers in documenting the ideas and experiences of the curriculum implementation process in depth and detail (Patton, 2002). Therefore, a qualitative inquiry approach was found to be suitable for the current study. In a qualitative study, depth and detail are captured by interviews, observations, and documents with small number of people and cases. However, the possibility of generalization is limited (Patton, 2002). The data of this study were collected through interviews since, as stated by Patton, interviews would provide direct record of people's experiences, views, feelings, and knowledge.

In the current study, the goal is to understand how middle school mathematics teachers interpret the issues about teaching transformational geometry and what meanings they ascribe to their experiences. For this reason, the design of the study fits the phenomenological research (Merriam, 2009). A phenomenological research aims to find out the meaning of experiences people have had and present a comprehensive description of those experiences (Moustakas, 1994). The focus in a phenomenological research is on “describing what all participants have in common as they experience a phenomenon” (Creswell, 2007, p.58). The current study described the issues experienced and stated by the participants. Based on the phenomenological research, it was assumed that the participants had similar experiences while planning and teaching transformational geometry.

3.2. Participants of the Study

The participants of this study were six middle school mathematics teachers from five different public schools in Ankara. The participating teachers were chosen on the basis of convenience in communication and access; they participated on a voluntary basis. All of the participating teachers were female. Four of the teachers had three, and two of them had four years of teaching experience.

In their current schools, four of the participating teachers’ average class sizes in their schools ranged from 40 to 50 students. Therefore, it may be considered that they were teaching “crowded” classes. One of teacher’s class size was 25. Two of teachers had been working in the same school since the beginning of their profession. The other four teachers worked in different schools. Prior to their current schools, two of them worked at urban schools, while the other two teachers worked at a rural school. The participants’ demographic information is presented below in Table 3.2:

Table 3.2 Participants' Demographic Information

	Years of Experience	Grades Taught	Schools of Employment	Major Graduation
Teacher 1	2 years	5,6,7,8	Public school in Ankara	Elementary Mathematics Education
Teacher 2	3 years	6,7,8	Public schools in Kırıkkale and Ankara	Elementary Mathematics Education
Teacher 3	4 years	5,6,7	Public schools in İstanbul and Ankara	Elementary Mathematics Education
Teacher 4	4 years	6,7,8	Public schools in Rize and Ankara	Elementary Mathematics Education
Teacher 5	3 years	6,7,8	Public schools in Samsun and Ankara	Elementary Mathematics Education
Teacher 6	3 years	5,6,7	Public school in Ankara	Elementary Mathematics Education

3.3. Data Collection

The data for this study were gathered by means of one-on-one interviews with six elementary mathematics teachers. The data collection tools and the process are explained in this section in detail.

3.3.1. Interview Protocol

To collect data from the participants, a semi-structured interview protocol was developed by the researcher. The interview protocol consisted of 14 main questions and related follow-up questions. The interview questions aimed at revealing the problems teachers experienced while teaching transformational geometry and their suggestions for overcoming these problems. The interviews started with questions regarding the teachers' basic mathematical knowledge on transformational geometry and then continued with questions related to the teaching of transformational geometry. Additionally, teachers' concerns about the curriculum related to transformational geometry, issues about students' learning outcomes, the national examination of level determination (SBS), instructional resources, effectiveness of their instruction, and the challenges they face were addressed. Finally, teachers were asked for their ideas in overcoming the problems they face while teaching transformational geometry. The demographic data of the participating teachers were also gathered through the interviews. The interview protocol is given in Appendix A.

The interview protocol was prepared by the researcher. In developing and finalizing the interview questions a faculty member and a Ph.D. student in mathematics education were asked to review the question in terms of clarity and appropriateness to the research questions.

3.3.2. Data Collection Procedure

The data collection procedure started after the necessary permission from the Ethical Commission in Middle East Technical University was received. The participating middle school mathematics teachers were chosen on a voluntary basis. The data were collected by means of interviews.

The interviews were conducted either in a room in the participants' school of employment or in the interviewer's house depending on the participants' preferences. The researcher made sure that there was nobody else in the room and there was no interruption during the interviews. One-on-one interviews started after a few minutes of general conversation, and then the interview questions were asked in the same order to all six teachers. Teachers were encouraged to express their views in detail about the problems they experienced while teaching transformational geometry. In order to do this, they were given time to respond, reflect, and consider their responses. Each interview lasted approximately one hour and it was audio-recorded. Audio-recorded interview data were transcribed verbatim and the transcriptions were reviewed by the researcher in order to ensure clarity and completeness for data analysis.

3.4. Data Analysis

Each interview, in which a voice recorder was used, lasted approximately one hour. The qualitative data obtained from these open-ended interviews were analyzed utilizing the content analysis method. Content analysis was conducted by the following steps. First of all, the data obtained through the interviews were transformed into a Microsoft Word format. The transcribed interviews were read several times to identify the problems or issues that participants faced in teaching transformational geometry. The data were first read by the researcher and the main issues that appeared in the responses for each interview question were noted. Recurring statements and issues were noted and a table was constructed including the frequency of the issues mentioned and the number of participants who mentioned the issues. The issues that emerged most frequently were coded for data analysis. After the codes of the transcribed interviews were finalized, they were checked by the researcher. After the coding phase, initial themes such as teacher, student and resource were gathered. The clustering process for common themes was repeated to provide sub-themes. These main themes and sub-themes are presented in Table 3.4:

Table 3.4 Themes and sub-themes of teachers' perceptions regarding issues and problems

Themes	Sub themes
Issues originating from teachers themselves	• Attitudes towards content • Visualization ability • Instructional procedures • Perceived content knowledge
Issues originating from students	• Visualization abilities • Attitudes • Prerequisite knowledge
Issues related to resources	• Instructional materials • Textbooks • Curriculum • Ministry of National Education

The clustering process resulted in three main themes with sub-themes. The first theme was issues originating from teachers themselves and it included attitudes towards content, perceived visualization ability, the instructional procedures they had been using, and their perceived content knowledge. The second theme was issues arising from students, which included visualization ability, attitude toward mathematics, and their prerequisite knowledge. The final theme was about problems related to resources and it consisted of instructional materials, textbooks, curriculum, and Ministry of National Education. All the interviews transcriptions coded according to the codes established by the researcher were recoded by a PH.D. student majoring in mathematics education at Middle East Technical University for purposes of consistency.

3.5. Quality of the Study

The practical standards that help researchers in judging the quality of the conclusions from the findings of the research can be referred to as the quality of the research (Miles & Huberman, 1994). The efforts and skills of the researcher determine the quality of a qualitative research (Golafshani, 2003). Therefore, the researcher's role throughout the data collection and analysis procedures will be described here in detail.

Before the actual interviews started, the researcher met the participating teachers to inform them about the research. The researcher has a friendship relationship with some of them. This situation might have impacted participants' responses both positively and negatively. They were assured that their responses would be kept confidential and that no connection between what they said and their identities would be made in the research report.

When the questions were not clear for the participants during the interviews, the researcher tried to express these questions clearly by asking sub-questions. The researcher generally summarized the participants' responses with one or two sentences before moving on to the next question and asked for participants' approval. Moreover, if the participants' responses were not clear or not related to the question, the researcher asked the same question again until the researcher felt that the participants' responses clearly addressed the interview questions.

After all the data were collected, the researcher reviewed the data and approached the participants again if there were incomplete or unrelated responses in the participants' data and completed them by conducting additional interviews.

In order to ensure the reliability of the study, the themes and sub-themes generated subsequent to coding were shown to the participating teachers. The teachers were asked about their views on whether the themes and sub-themes were appropriate and whether there were other themes or sub-themes that could be added. The themes and sub-themes were revised based on the feedback of the teachers. During data analysis, the codes created by the researcher were checked by a faculty member in the department of mathematics education and a Ph.D. student majoring in mathematics education. A second coder also coded the data. Both coders initially read the transcriptions of the interviews in order to reach a common understanding of the data for further coding decisions. Subsequently, the coders determined the codes that would be used in the analysis and coded the data together. This helped the coders to reach a common understanding for further analysis. The processes of coding and reaching initial themes were monitored by the previously mentioned expert in mathematics education.

3.6. Assumptions

This study was based on various assumptions. The first assumption is related to the interview questions. It was assumed that the interview questions were sufficient and appropriate in serving the purpose of the study. Another assumption is in relation to the participating teachers. It was assumed that the participating teachers responded to the interview questions sincerely and reflected their opinions impartially. One other assumption of the study was that the expert opinions received during the preparation phase of the interview questions used in the study were sufficient. Finally, it was assumed that the researcher did not have a prejudice against the participating teachers during the implementation of the study and the interpretation of the data collected.

3.7. Limitations

The number of participating teachers was limited to a total of six elementary mathematics teachers who were working at schools in various regions of Ankara in the academic year of 2012-2013. The limited number of participating teachers does not allow the researcher to generalize the findings to a larger group of teachers. Additionally, the findings of the study were limited to the responses of the participating teachers since the participants' views were not supported by observation of their teaching practices; the findings were limited to their views.

CHAPTER 4

RESULT

This chapter presents the main findings of the study: the problems that teachers face in implementing transformational geometry. The findings are reported under three major categories: (i) issues about teachers themselves, (ii) issues about students, (iii) issues about resources. Each category is further divided into three parts: (i) the problems, (ii) perceived reasons and solutions of these problems, (iii) suggestions for overcoming the problems.

4.1. Issues about Teachers

This section describes the problems originated from the teachers themselves, reason of these problems, the ways teachers overcome these problems, and finally additional ideas of teachers for overcoming the problems.

4.1.1. Problems Arising from Teachers in Teaching Transformational Geometry

Teachers explained that they were faced with problems while teaching transformational geometry. Based on the interview data with teachers, problems were divided into sub-themes of content knowledge, attitude, instruction, visualization, and assessment.

Some of the teachers in this study lacked knowledge in transformational geometry. As a result of the interviews held with the teachers, it was found that some teachers were aware of their deficiencies while some indicated that they needed to think further on this issue, On the other hand, two of the teachers claimed that they did not lack knowledge in this topic even though they provided incorrect definitions. Most of the participating teachers had problems defining the concepts of transformation, reflection, glide reflection and rotation. None of the teachers could give an accurate definition of the concepts. They tried to explain the concepts by giving an example. Some teachers even gave incorrect examples. The interviews conducted confirm that teachers lack knowledge in transformational geometry. For example one of the teachers said that transformational reflection and reflection translation are the same. Another teacher stated that rotation was a rotation movement of a shape. One of the teachers gave a wrong definition. She defined the concept as follows: “It is transformation, rotation and reflection movement of a shape” (T5). One of the teachers said, “I cannot provide a clear definition but I can give examples about these concepts” and she continued by saying “transformational rotation and rotational transformation are different. They are not the same” (T3). The following comments reflected how a teacher gave the definition in detail:

> *“Transformation is the movement of a point either five units to the right-left or down-up. The reflection of a point according to a specific line is called reflection. Rotation is the movement of a certain point in different angles*. (T6)

All of the teachers were concerned about the eighth grade rotation topic. Four of the teachers also expressed that they did not make use of visualization, which made them worried while teaching rotation. Teachers were concerned about teaching rotation because they thought that they did not have self-confidence in teaching rotation. One of the teachers said, “I was not concerned about translation and the reflection topic but when we came to the rotation topic in eighth grade, I got concerned because I had problems about visualization” (T2). Another teacher stated, “For example, we cannot teach 45° rotation of a shape; students must imagine it by themselves in order to understand the 45° rotation of a shape. Because I cannot teach rotations of such angles as 45^0, this makes me worried and disturbed while teaching, and this situation disturbs me” (T3).

Problems in instruction were lack of the visualization ability and lack of content knowledge. Generally, teachers faced problems when they taught rotation in the eighth grade. In transformation, reflection and glide reflection they did not face any problems. According to teachers, the greatest problem while they teach rotation is their visualization ability. One of the teachers said, “I cannot see the rotation of a shape, especially like 45° intermediate angles. I cannot rotate. I have visualization problems and when I teach rotation, I give the rule of rotation of a point because I cannot teach visualization. Students can make visualization by themselves so I have to give the rule of rotation" (T3). This rule involves finding rotated images of the shapes not visually, but by using the ordered pairs of the points on that shape. For instance, to rotate the point (3,-2) around the origin, 90° clockwise they just change the sign of *x* and interchange the numbers, and as a result, obtain (-2,-3). Other teachers stated similar concerns. The following quote exemplifies these views:

> […] *"For example, when I taught rotation for the first time, I was very worried. I went to an expert math teacher before the lesson to ask him how I could teach rotation. He said giving the rule of rotation directly is enough. This is a very tedious memorization of rule, but it's really hard to make children think about it. First of all, I tried to explain how the visualization of a shape's rotation could be done at eighth grade but nobody could understand, so I had to give the rule of rotation in the book"* (T2).

Another problem in the instruction of transformational geometry was that teachers did not make any connections with other courses. Three of the teachers said that they did not know the content of other courses. Three of them stated that they knew the content of other courses but they did not make connection with other lessons and transformational geometry.

The greatest problem that teachers faced in teaching transformational geometry was their visualization ability, especially in rotation in the eighth grade. Four of the teachers said that they could not make visualization and two teachers said they could make visualization, but it takes time, because they forced while making visualization of rotation. Four of the teachers taught rotation directly by giving the rule of rotation due to their lack of visualization ability.

The following comments reflected how visualization was a big problem for teachers in detail:

> *"There is rotation of polygon in the eighth grade curriculum where I did not understand; thus, I cannot explain it to the students. Therefore, students also find it hard to understand. Students ask questions from the test book. In order to solve them I need to think for a long time. Doing rotational transformation is a problem for teachers and also for students."* (T1)

> *"I cannot explain the polygons' rotation of angles except for 90°, 180°, 270° and 360°, which is my insufficiency. However these questions are not asked in the SBS examination."* (T5)

Finally, problems related to teachers' assessment procedures will be explained. Teachers used project-performance tasks and examination results for assessment. One of the teachers also used quizzes and two of the teachers used only exam results and did not use project-performance tasks, because four of the participated teachers did not believe that such tasks are useful for students. One of them said:

> *"I do not believe project-performance tasks are useful for students. They do not do this task. Their parents complete the tasks for them. I think only exam results and their attitude in class are sufficient for assessment. There is no need for such tasks"* (T3).

Another teacher said, "Only a few students have been doing these tasks. These students are the ones who already understand the lesson" (T4).

In brief, the most important problems in the teaching of transformational geometry originated from the teachers' lack of skills in visualizing transformations and their lack of content knowledge. None of the participating teachers could give a complete and exact definition of the concepts in transformational geometry. Some of the teachers gave incorrect examples and definitions. All of the participating teachers stated that they had problems with visualizing some of the transformations. Teachers stated that they did not have any problems in translation and reflection, but they faced problems especially in rotation.

4.1.2. Reasons and Solutions of Problems Arising from Teachers in Teaching Transformational Geometry

In this part, reasons and solutions of problems arising from teachers will be explained. Reasons and solutions are explained in the following order: content knowledge, attitude, instruction, visualization, and assessment.

Teachers could not give a definition of rotation, reflection and transformation because they did not know the exact definition. They attempted to describe the concepts of transformational geometry by giving examples. Two of the teachers said, "I know I am insufficient in some areas, but it changes in time with experience"(T2 and T4). All of the teachers were not concerned with content knowledge problems; they seemed to accept the situation and they thought that time and experience would solve this problem. One of the teachers said, "I'm trying to improve myself as best as I can, but I do not have enough time for it. I believe that when I gain experience about transformational geometry, this problem will end" (T6).

As explained earlier, teachers thought that the reason of their concerns in teaching rotation is their insufficient visualization ability. If they improve their visualization ability, their concern will disappear.

According to teachers' opinions, they could not make visualizations because they had not learned these topics when they were students. A teacher said:

> *"I cannot make visualizations because I learned these topics at university. But if I had learnt transformational geometry when I was in elementary school, I would absolutely visualize the shapes. In addition, if I were taught transformational geometry while I was in middle school, it would have been be easier for me to explain it to my students."* (T5).

According to data obtained from teachers, the main reason for teachers' visualization problem was their university education, where they did not have the chance to study these topics. Especially novice teachers thought that they could solve this problem by improving their visualization ability over time. So far, they have done nothing to solve this problem.

Another problem in instruction of transformational geometry was its connections with other subjects and with other concepts of mathematics. None of the participating teachers made connections with other subjects, because they do not know the content of other courses and also they do not give importance to the relation of mathematics to other courses. Only one of the teachers said, “Now I realized that I did not connect mathematics and other subjects but I should make a connection. It is useful for students and also for me” (T6).

Regarding the assessment, all teachers used exam results to assess students' performance. One of the teachers used exams and quizzes and three of them used project or performance tasks. In the evaluation of project performance tasks, teachers used rubrics given in the textbook, but they changed the scores in the rubric to assess project performance tasks. Three of the teachers raised the scores when evaluating. The reason of this was to motivate students by giving high scores. One of the teachers stated, “I did not face a big problem because I raised the project-performance tasks' scores in order to motivate the students” (T5).

To sum up, none of the participating teachers gave the correct definition of the concepts in transformational geometry. The reason of this problem seemed to derive from the lack of participants' content knowledge. To overcome this problem, when teachers teach transformational geometry, they give the definition by using examples. Most of the teachers did not have self-confidence in teaching rotation. The reason for this poor self-confidence might be the participants' lack of visualization ability. All teachers said that they had visualization problems because according to teachers they did not have experience with such visualizations in their educational life.

4.1.3. Suggestions Proposed by Teachers in Overcoming Problems Derived from Themselves in Teaching Transformational Geometry

In this part, teachers' suggestions or ideas for overcoming the problems they face are explained. All teachers suggest that mathematics education courses in teacher education programs should be improved to prevent lack of content knowledge. One of the teachers stated :

> *"According to me, it is necessary to increase the number of courses related to the art of teaching mathematics in the university curriculum. Also, the content of the education courses should be enriched. The content of the courses should be handled in more detail. There should be courses at university education in which students can learn and discuss the challenges of a teacher"* (T3).

One of the teachers said: "At the university, the number of courses on the method of teaching mathematics should be increased. These courses are taught as of second year in the university" (T6).

Three of the teachers proposed that to improve their visualization ability of transformational geometry, they need to have opportunities to improve this ability during university education. At the university, more opportunities should be provided to pre-service teachers to improve their visual abilities. In addition, two of the teachers expressed their need for in-service training on this issue. They recommended that an online video conference on the new topics in the curriculum like transformational geometry would be helpful for them. New topics should be explained in the videos and also teachers could ask questions about the difficulties that teachers face.

All of the participating teachers complained about the class size and they would appreciate if the number of students in a class was reduced. One of the teachers stated, "I want to provide individual care for every student in my class to help them understand the lesson. To do this, class size must be reduced" (T3). Another teacher said, "I want all students to solve questions one by one but in this condition it is not possible. The Ministry of National Education should reduce the class size to 25 students" (T5).

To summarize, all teachers suggested that mathematics education courses should be increased and improved at university level. Most of the teachers expressed the need for in-service education on transformational geometry in order to overcome the problems they face regarding teaching transformational geometry. All of the teachers recommended decreasing the class sizes.

4.2. Issues about Students

This section describes the perceived problems related to students, the reasons of these problems and the ways teachers overcome them, and finally further suggestions of teachers for overcoming these problems.

4.2.1. Problems Related to Students in Teaching Transformational Geometry

The participating teachers stated that they experienced problems arising from students while teaching transformational geometry. Based on the data obtained from teachers, the problems were divided into some sub-themes. These sub-themes are the visualization ability of students, students' attitudes toward the course, and prerequisite knowledge of students.

First of all, problems regarding students' visualization of transformational geometry will be explained. According to the participating teachers, most of the eighth grade students have difficulty in rotation. Teachers argued that students have problems in rotation because of their difficulties in visualizing rotation. Teachers stated that a few students could make visualization easily, but the others could not. One of the teachers said, "Students' visualization ability is really poor. There are very few students who can make visualization by themselves" (T1).

All teachers said that most of the students tried to memorize the rule of rotation in order to make rotation. This rule involves finding rotated images of the shapes not visually, but by using the ordered pairs of the points on that shape. For instance, to rotate the point (3,-2) around the origin 90° clockwise they just change the sign of the *x* intercept and interchange the numbers, and as a result obtain (-2,-3). According to teachers, this approach caused a problem because students had difficulty in remembering the rule of rotation. Three of the teachers claimed that students had to learn visualization but that visualization could not be taught. They claimed that some activities improved students' visualization ability but students should make effort to improve the visualization ability. The following excerpts illustrate some of the teachers' views about the problem of students' visualization ability and all the other teachers think in the same way.

> *"Especially, students cannot rotate polygons' angles except for 90°, 180°, 270° and 360°. We need to make students think about the visualization of shapes. This is very difficult. We cannot do this. Students have to understand by themselves. They just want to memorize the rule of rotation because they did not understand it themselves and the teacher did not teach visualization"* (T4).

> *"Students cannot rotate the shape visually. There is really a trouble about rotation. Students cannot imagine the shape, and then they want to memorize the rule of rotation"* (T5).

> *"Students cannot visualize the rotation of a shape. If they know the rule of rotation, they apply it. Unfortunately, most of the students do not know the rule of rotation"* (T6).

Students' attitude toward the course was another issue raised by the participating teachers. They generally complained that students did not give importance to the course. Most of the students thought that mathematics was very difficult. Because of this, they were not willing to learn mathematics and more specifically transformational geometry. All of the teachers said that most of the students had negative attitudes toward mathematics. Because of this, they were not paying attention to the lessons. They did not study for the lessons by themselves and they did their homework in a sloppy and incomplete manner.

Another problem related to the students is the lack of their prerequisite knowledge. All teachers mentioned that students had problems as regards their prior understanding of prerequisite concepts related to transformational geometry. Students did not understand transformational geometry because they could not do addition and subtraction operations of integers. They do not know what the coordinate system is and how they can use it. They have lack of understanding of such concepts necessary to study transformational geometry. The following citations exemplify this view:

> *"We have difficulties caused by students especially in eighth grade's topic which is rotation in transformational geometry,. This is due to lack of information from previous years. In fact, if they had learned previous class' topics, we would not have problems. Students in eighth grade still do not know operations in integers. How can I teach rotation? I think this is the biggest problem for us"* (T3).
>
> *"Prerequisite knowledge of the students is very important and unfortunately there is a great lack of prerequisite knowledge. When I start a new topic, I have to recall the past years' content. This situation takes a lot of time. Because of this, I always have to solve simple examples and I cannot solve enough problems in the new topic"* (T6).

All of the teachers mentioned that the issues related to students depended on the grade level. Teachers indicated that they faced many of the problems in eighth grade; they observed almost no problem with sixth or seventh grade students. For example, one of the teachers said,: "There is no problem in sixth grade transformational geometry topics but I have problems with eighth grade transformational geometry topics" (T1).

Briefly, all of the participating teachers mentioned that there was a serious problem in relation to students' visualization ability in transformational geometry. They argued that students could not make visualization of transformational geometry topics; specifically, they cannot imagine rotated images of plane figures. Another problem is students' attitudes towards mathematics. Many of the participating teachers stated that students did not give importance to math classes. They did not pay attention to the topic and they did not do homework; consequently, they did not understand the topics. Finally, most of the teachers mentioned that students' level of prerequisite knowledge was insufficient to understand the topic. They lacked understanding of previous years' topics.

4.2.2. Reasons and Solutions of the Problems Related to Students in Teaching Transformational Geometry

In this part, perceived reasons of the problems related to students in teaching transformational geometry are explained. In addition, teachers' ways of overcoming these problems are explained.

Most of the participating teachers denoted that students did not have sufficient visualization skills. For example, one of the teachers said, "Students are not familiar with visualization. They just see the shapes and rotation shapes in the book. So, they do not understand how rotation occurs" (T2). To overcome this problem, three of the teachers tried to teach by using materials in order to provide visualization easily One participant stated,, "I draw the coordinate system on a cardboard paper and rotate the shapes in a coordinate system to provide visualization" (T5). The other three teachers said that they were just giving the rule of rotation. One of these teachers stated, "I give the rule of rotation to overcome the visualization problem because providing visualization is very difficult for me. There is not enough concrete material and technological materials or computers in order to provide visualization" (T1).

All participating teachers thought that one reason of students' attitude problem was the lack of their basic mathematical skills. They stated that when students do not have prerequisite skills, they do not understand the lesson. When they do not understand the lesson, then they develop a negative attitude toward mathematics. The following excerpt illustrates this view:

> *"A small number of students volunteer to listen to the lesson. Some of the students did not know multiplication facts, and also they cannot do multiplication and subtractions of integers. So, they do not care about the lessons because they do not have any idea about the lesson. This situation is really difficult for us. If I repeat the previous year's lessons, there will not be enough time for the new topics"* (T1).

To solve this problem, three of the teachers believed that if teachers can make students like mathematics, their attitude toward mathematics will change. In this way, they will try to understand mathematics and they will study their lessons. One of the teachers said, "As a mathematics teacher, we have to change students' negative viewpoint. I know this is very difficult but everything will be much easier after succeeding this" (T6). The other three teachers thought that if students could pay attention in the mathematics lesson, their attitudes would change. Otherwise there is no way they can help the students.

Two of the participating teachers believed that the reason underlying students' lack of basic prerequisite mathematical skills might be due to frequent change of mathematics teachers in their school. One of teachers said, "Every year, the classes I teach changed. This is a problem for students and for us, because I do not know how and how much was taught by the other teacher" (T2). The other four teachers claimed that the reason underlying the lack of prerequisite knowledge was caused by primary school teachers who teach from grades 1 to 4. They stated that if middle school mathematics teachers taught mathematics sufficiently, now they would not be facing this problem. In order to overcome this problem, before starting the new topic, teachers gave a brief summary of the previous years' topics. One of the teachers remarked, "Before starting a topic, I explained the previous topics; otherwise, students do not understand anything" (T3).

In summary, most of the participating teachers viewed that students' do not have sufficient visualization skills because they are not familiar activities of visualization from the previous years. To overcome this problem, one of the teachers tried to produce as many materials as possible. According to the participating teachers, the reason of the students' attitude problem is students' lack of basic mathematical skills. Two of the participating teachers claimed that the reason underlying this was the change of teacher every year and middle school mathematics teachers' poor mathematics teaching performance. To overcome this problem, participating teachers give a brief summary before starting to a new topic.

4.2.3. Participants' Suggestions for Overcoming Students' Problems in Transformational Geometry

In this part, teachers' suggestions for overcoming students' problems in transformational geometry are explained. Teachers proposed only a few suggestions regarding this problem.

All the teachers participating in the study suggested making use of technology. They claimed that the students in class would pay much more attention in mathematics class and overcome the problem of visualization If the use of technology were made more prevalent, According to the views of teachers, if the use of technology becomes more widespread, transformational geometry instruction for teachers, and understanding the topic for students may become much easier and unproblematic. For example, one teacher said, "I believe that if a projector and computer are installed in the classrooms, problems arising from students will reduce to minimum. According to me, technology is a must to reduce these problems" (T3).

One of these suggestions, as proposed by four of the participating teachers, was that a the same teacher should continue to teach across years. They stated that to prevent the prerequisite knowledge problem, the same mathematics teacher should continue teaching in all grades. To illustrate, one teacher remarked, "I think, if a teacher started a class, s/he should continue with this class. A change in teachers affects students negatively" (T5).

Three of the participating teachers suggested that mathematics teachers should teach mathematics classes as of fourth grade. Primary school teachers should teach mathematics just in first, second and third grade. One of the teachers stated, "I absolutely think that mathematics teachers should teach mathematics as of fourth grade in order to prevent the prerequisite knowledge problem" (T2).

All of the participating teachers stated that students should be willing to listen to the lesson. They stated that the textbook should be changed in order to attract students' attention. One of the teachers said, "There should be more educational games in the textbook so that we can draw students' attention to the lesson easily" (T1).

4.3. Issues about Resources

This section describes the perceived problems originating from the resources, the reasons underlying these problems and the ways teachers overcome them, and finally the suggestions proposed by teachers for overcoming these resource problems.

4.3.1. Resource Originated Problems Experienced by Teachers in Teaching Transformational Geometry

Interview data indicated that teachers face problems arising from resources while teaching transformational geometry. According to the data obtained from teachers, problems were divided into some sub-themes. These sub-themes are materials, textbook, curriculum, and the resources of the Ministry of National Education.

All participating teachers argued that lack of concrete material and technological materials was the biggest problem for teachers especially in transformational geometry. For example, there is no projection or computer in the participating teachers' schools. Teachers have too many problems in teaching transformational geometry due to lack of concrete material and technological materials. One of the teachers expressed his/her view as follows:

> *"There is only a board and a board marker in our school as material. In rotation, I have to draw a coordinate system and also a shape on the board. When I rotate the shape, I have to draw the coordinate system again. It takes too much time. I can work on just two or three questions in the lesson. This many questions, is certainly not enough in rotation. Classes are crowded and there is not enough technological material. How do you expect to teach in these circumstances?"* (T5).

Not many teachers use hand-on manipulative. Only two teachers design activities and concrete materials from cardboard and use them in class. To illustrate, the teachers who developed his/her own concrete material said as follows:

> *"I myself prepare my own material. In our previous school there was an overhead projector. I used to use it to compensate for the lack of technology, but this school does not even have this. So I design activities using cardboard when I have time and use them in class. And I benefit from them a lot. So if there were a little more material, we could teach more effectively"* (T6).

However, most of the teachers stated during the interviews that they would use an overhead projector if it were available.

All the participating teachers expressed the same idea. They want a projection and a computer in every classroom. Otherwise, they cannot provide visualization in rotation.

Teachers also mentioned problems regarding the textbook they were using. None of the participating teachers used a textbook. There were not enough questions in the textbook and the type of the existing questions was not similar to the ones in SBS. Activities were not appropriate to all public schools. To illustrate, a teacher said:

> *"Questions in the textbook are open-ended and based on interpretation but in SBS all the questions are multiple choice. Moreover, the difficulty levels of the questions are not the same as the questions in the book. If students want to pass the SBS with a good score, they have to prepare for it with a test book because the questions in the text book are not enough. Doing some activities [given in the textbook] is really difficult because there is no concrete material and technological material and also there is not enough time in the curriculum."* (T6)

Another problem regarding the textbook is the description or the explanation of the concepts or procedures. All participating teachers mentioned that the explanations of the topics were insufficient in the textbook. All teachers claimed that when students study a topic in the textbook on their own, they should understand the topic, but with our textbook it is impossible. One of teachers stated:

> *"If students did not come to the lesson, later they should study the topic in the textbook, but [with these textbooks] they cannot. Our textbook depends on teachers. First, the teacher explains the topic, and then the student should study the topic from the textbook. Explanations in the textbook are very difficult for students to understand, even sometimes for us. All the mathematics teachers I have ever seen, including myself , do not use the textbook. The textbook is certainly not useful."* (T2)

The next problem stated by the teachers was about the mathematics curriculum. All participating teachers stated that the time specified in the curriculum was not enough for the rotation topic in eighth grade. They said that the allocated time for translation and reflection was sufficient, but time for rotation was not sufficient for eighth grade students to gain a sound understanding. The following utterance illustrates one of the teacher's views:

> *"I have enough time to work on problems in translation and reflection but in rotation, time is a big problem in eighth grade. Time given for rotation in the curriculum is not enough. During this time students do not understand rotation because I can work on only a few questions in the given time. If I had enough material, I could solve many more questions so that the topic could be understood by students."* (T3)

The last problem was about the resources of the Ministry of National Education. All participating teachers thought that the website of the Ministry of National Education was not useful for teachers. When they wanted to get information about the topics that had recently been added to the curriculum, such as transformational geometry, they could not reach the information about these topics on the website of the Ministry of National Education. In addition, they said that the ministry did not conduct in-service training about how teachers could teach such recently added topics. One of the participating teachers' views exemplifies this:

> *"I expected some informative data on the website of the Ministry of National Education when I faced a problem about teaching. In teaching rotation, I had difficulties during lecturing. After the lesson I looked at the website of the Ministry of National Education in order to solve my difficulties. I thought maybe they could provide me with information that would help me but there was nothing about rotation on the website."* (T1)

To summarize, the greatest problem in relation to materials is the absence of technological materials. All participating teachers complained about the lack of technological materials. Still, all the participating teachers claimed that they did not use the textbook because the questions and activities in the textbook were not enough. They used different testbooks in the lessons. Also, activities were not appropriate for all schools' physical environment. The textbook was not parallel with SBS. They thought that the given time for translation and reflection was sufficient but the time given for rotation in eighth grade was definitely not enough. Lastly, the website of the Ministry of National Education does not respond to the teachers' problems. Also, teachers complained that the Ministry of National Education did not provide in-service training on problematic topics like rotation.

4.3.2. Reasons and Solutions of the Resource Originated Problems Experienced by Teachers in Teaching Transformational Geometry

In this part, perceived reasons of the resource originated problems experienced by teachers in teaching transformational geometry are explained. In addition, teachers' ways of overcoming these problems are explained.

Two of the teachers prepare their own material in order to overcome the problems they face related to resources. One of these teachers stated: "In rotation, visualization is necessary. I have to prepare materials for my lesson" (T1). The other teachers do not prepare materials, so they teach the course by direct instruction. All participating teachers thought that the Ministry of National Education should provide concrete and technological materials for all schools. One of the teachers said, "I cannot do anything about lack of materials. If ministry provides materials for school, we can teach especially the geometry topics easily” (T3).

The participating teachers stated that they did not use the textbook in their classes. To overcome the perceived problem of textbook, all teachers said that they were using other test preparation books. One of the teachers said: “When I prepare for a class, I use different test preparation books to find different questions” (T4).

All the teachers said that one reason for the time problem in the mathematics curriculum is the lack of students’ prior knowledge. Before starting the new topic teachers give a summary of the previous year’s topics. According to teachers, it takes extra time to overcome students’ lack of understanding in prerequisite concepts. One of the teachers said, “I give a summary of the previous topics, then I start the new topic” (T2).

To sum up, two of the participating teachers produced their own material to overcome the material problem. None of the participating teachers used the official textbook. They used test preparation books when they needed questions to use in their classes. Moreover, to overcome the problem of time originating from students’ lack of understanding of the prerequisite concepts, all participating teachers were reviewing the previous topics in class.

4.3.3. Further Suggestions of Teachers for Overcoming Resource Originated Problems Experienced in Teaching Transformational Geometry

In this part, teachers’ further suggestions for the problems regarding resources are explained. One of these suggestions put forward by all of the participating teachers is that a computer and a projector should be installed in all classrooms so that teachers can provide visualization. Four of the teachers suggested having smart boards in all classes. However, the most important requirement for teachers is a computer and a projector. One of the teachers said:

"I would like to teach transformational geometry topics by using dynamic geometry software like Geometer's Sketchpad. I can make translation with a single click instead of drawing shapes on the board, which takes a long time. Using technology facilitates visualization of transformational geometry. I think students' visualization ability will be developed by using technology." (T6)

All participating teachers claimed that the textbook must be updated and some changes should be done. For example, examples given in the textbook should be more attractive. The number of different types of examples should be increased. Explanation of topics in the textbook should definitely change. When students study the topic in the textbook on their own, they should be able to understand the topic. Question types should be changed because they are not parallel to the questions in the SBS. As a result, all participating teachers demanded a change of the textbook from the beginning to the end so that the textbook could be more useful. One of the teachers stated:

"In my opinion, to make the textbook more usable, examples, questions, explanations of the topics need to be changed. One day a student asked me why the Olympics of the year 2004 were mentioned in the question. Wasn't the Olympics held again since 2004? He is right. The textbook must be updated. Questions, examples, explanations of the topics have to be revisited. Especially the questions in the textbook should be parallel with those in SBS because each student may not receive a test book." (T5)

All participating teachers thought that there was no lack of information in the curriculum, but time was not sufficient for eighth grades. Teachers argued that time devoted to rotation in eighth grade should be increased. They wanted rotation lessons in eighth grade to extend from two hours to at least four hours.

Four of the participating teachers suggested that the Ministry of National Education should place on their website different types of activities, which are applicable for different conditions. One of the teachers said: "When I visit the website of the ministry, I should find different things from those that are available in the textbook. Some helpful resources for teachers should be placed on the website" (T4). Three of the teachers suggested that there should be video conferences or in-service training for recently added topics. One of the teachers stated:

> *"There should be in-service training for newly added topics like transformational geometry because when a student says that he/she did not understand these topics, I cannot predict which point the students do not understand. Preparing seminars will be difficult and expensive but I think they can make video conference seminars."* (T5)

In summary, all participating teachers stated that instructional materials should be available in every school. They also suggested a computer and a projector to be installed in each classroom. Also all participating teachers suggested that textbooks should definitely be revised. According to the participants, the allocated time for teaching rotation should be increased in the curriculum. Finally, they want seminars or video conferences for newly added topics like rotation.

CHAPTER 5

DISCUSSION AND RECOMMANDATIONS

The main purpose of this study was to identify and describe middle school mathematics teachers' problems about transformational geometry. Specifically, this study focused on teachers' problems regarding transformational geometry, the difficulties they faced, and the suggestions they proposed as possible solutions for their problems during the implementation of transformational geometry. In this chapter, the major findings of the study is summarized and discussed under three main categories, followed by recommendations for future research.

5.1. Discussion on the Teacher Issue

In this study, the participants mentioned the challenges they faced in teaching transformational geometry. In this section, the findings in relation to the teacher issue are discussed.

It is stated in the literature that teachers' lack of content knowledge has a negative impact on students' teaching; hence, if teachers understand the topic in depth, they can select effective activities (Ball, 1990). The deficiencies in teachers' content knowledge have a negative impact on student success (Monk, 1994). One of the findings of the study in relation to teachers, which was obtained as a result of the interviews held with mathematics teachers, is that teachers may have problems in content knowledge of transformational geometry. Most of the teachers who participated did not give definitions of concepts in transformational geometry during the interviews. In conclusion, teachers should know the content knowledge and mathematics in depth for effective teaching performance as supported by the findings of the study. Keleş's (2009) study consistent with this finding. He stated that teachers have lack of content knowledge about newly added topics

The other important finding of this study was that both mathematics teachers and students have deficiencies in perceived visualization ability.. Teachers' deficiencies in spatial visualization may be a contributing factor in the difficulties students face in learning transformational geometry, especially in the rotation topic. According to participants of this study, when teaching transformational geometry, both teachers and students experienced difficulties in making visualizations. In the literature, several studies are consistent with the results of the present study. For example, both students and teachers have difficulties in understanding and the visualization of the notions of reflection, rotation, and translation (Desmond, 1997; Edwards & Zazkis, 1993; Law, 1991).

The findings of the study showed that participating teachers had difficulty in carrying out activities because of the lack of material and technology. Thus, lack of material and lack of technology are other important factors affecting the implementation of the process of transformational geometry. The teachers stated that when they tried to use activities in teaching transformational geometry, they could not implement most of the activities, because there was not enough material and technological tools, and the activities took too much time. When teachers taught rotation, they wanted to use materials in order to demonstrate it visually. When they used computers, dynamic geometry tools or concrete materials, students learned the topic more effectively. Similar to the findings of the study, Kalender (2006) stated in his/her study that the most important reason of the problems teachers experienced in teaching the topic and implementing activities was the lack of material. Yet in another study by Erduran and Tataroğlu (2009), it was stated that the problems teachers faced during teaching and implementation of activities derived from lack of materials and the difficulty in finding them.

The addition of new topics to the curriculum caused an increasing workload for the participants, especially for the mathematics teachers in this study. This situation might have caused teachers to have time management problems in teaching transformational geometry. Especially in rotation instruction, the time allocated was not sufficient for teachers, which result in problems in time management. This finding has been commented on and supported by the study of Erbas and Ulubay (2008), in which many sixth grade mathematics teachers complained from both excessive content and lack of time, claiming that implementing the activities in the curriculum took too much time due to lack of material and a lack of visualization ability. They believed that if the content of the curriculum was reduced, this problem would disappear. Also Erbas and Ulubay (2008) commented that an increase in the duration of the mathematics lesson was unrealistic within the weekly program of grades 6–8.

The participants also recommended an increase in the duration of the mathematics lessons in order to implement transformational geometry. Teachers suggested that the time allocated for translation and reflection was sufficient but the time allocated to rotation should be increased to 4 hours. They suggested that there should be a consistency between the content load of the curriculum and the time allocated. As reported in Erbas and Ulubay’s study (2008), teachers complained about the shortage of class time to cover all the content objectives with activities suggested in the curriculum. Erbas and Ulubay (2008) commented that curriculum developers and policy makers should seriously consider narrowing the content and allowing teachers and students more time to study the concepts.

According to the findings of the study, teachers do not feel competent in the newly added topics, especially in rotation. They feel the need for training programs that could support them. They claimed that in-service training seminars could be of benefit to them. Gürbüz (2009) stated that teachers having received in-service training are more successful than the other teachers. As seen in the findings of our study, teachers should attend in-service training on the newly added topics (e.g., transformational geometry) in order to be more successful. There are studies in the literature that supports this conclusion. For example, Bıkmaz (2006) aimed to determine some issues that could lead to misunderstandings in the curriculum and explain and justify why they could be misunderstood. Bıkmaz revealed that teachers, who were to put the changes in effect, were not supported with respect to the implementation of the new program and left on their own. It was concluded that teachers needed in-service training in especially the newly added topics and how these topics could be taught but did not receive it.

Teachers also suggested that, in undergraduate education, some courses on the new topics like transformational geometry should be added, because if teachers learn newly added topics at university, they will be able to teach these topics more effectively. The teachers participating in the study said that they would have experienced fewer problems if they had received more courses at university on mathematics instruction. They claimed that the content of the undergraduate courses should be parallel to the curriculum outlined by the Ministry of National Education and that they should be specified in relation to the courses they were to teach after graduation.

Similar to this finding, in a study by Ulubay (2007), it was stated that a good leadership is necessary to motivate teachers to implement the recommended activities and topics. The Ministry of National Education or education faculties of universities can meet this requirement. Parallel to the findings of this study, in the study conducted by Işık, Çiltaş and Baş (2010), it was indicated that since teaching was a profession of expertise, special attention should be given to teacher education in terms of content education, training in methodology, and teaching practices and that the education issue should not be left to chance. The reorganizations in education should be reconsidered from this perspective: Teaching practices should be increased, the pre-service education courses that teachers are to receive should be reorganized so that they sufficiently meet the needs of teachers in their teaching practices after graduation, and the number of elective courses should be increased. Moreover, they arrived at the conclusion that the courses based on teaching experience and practices offered at the education faculties should be designed more carefully and professionally, and then in-service training programs should be organized.

Based on the findings of the current study, it can be suggested that high quality support to inexperienced teachers in teaching transformational geometry should be provided.

Although all teachers have such a need, findings of this study suggested that teachers with less experience may need further attention; hence, contact should be maintained with teachers having completed their teacher education programs, especially during their first years in the teaching career. The finding of a study by İşler (2008) supports this finding of the study. İşler also arrived at the conclusion that all teachers, primarily inexperienced teachers, should be given support.

5.2. Discussion on the Student Issue

One of the findings regarding students is that students have a negative attitude toward mathematics. According to the teachers participating in the study, because students display a negative attitude toward mathematics, they experience problems in transformational geometry as well. Teachers claimed that the negative attitude of the students caused students to display behavioral habits like not paying attention to the transformational geometry lesson or to the problems solved in class, and not completing their homework. The role of attitude is significant in whether students are successful or not and in their level of motivation (Çoban, 1989). Taking into consideration the findings of the study as well, it can be said that if the negative attitude of students can be changed, a higher level of success can be achieved in transformational geometry. Identifying students' attitude toward mathematics lessons at the right time will make significant contributions to their future educational life and, thus, the quality of education can significantly be improved. One reason found, as a result of a study by Özyürek (1992; 2002), for the negative attitude students displayed toward mathematics lessons was the crowdedness of classes. The studies in the literature confirm this finding. For example, in a study by Taşdemir (2009), students were found to display a negative attitude toward mathematics lessons, and it was claimed by Taşdemir that knowledge and experience were important means to eliminate negative attitudes and that negative attitudes should be eliminated as early as possible.

Another finding of the present study in relation to students was that students had lack of knowledge from previous years. In the studies by Zembat (2007), Ersoy and Duatepe

(2003) and Faydacı (2008), it was stated that it was a prerequisite for students to have knowledge in many concepts to understand transformational geometry. All the teachers participating in the present study also indicated that students experienced problems in terms of their level of readiness. Teachers claimed that because students lacked the prerequisite knowledge, the desired level of success in transformational geometry could not be obtained.

Another finding in the present study in relation to students was that, just like the teachers, students also lacked the visualization ability. The teachers participating in the study asserted that there were deficiencies in the visualization ability of students. Based on the claims of the teachers, it was found that one of the reasons underlying the problems experienced in transformational geometry could be the lack of visualization ability of students. According to the teachers, if the visualization ability of students can be developed, a higher level of success in transformational geometry can be achieved. This finding is in consistency with the findings of other studies in literature (Desmond, 1997; Edwards & Zazkis, 1993; Law, 1991).

5.3. Discussion on the Resource Issue

Although in literature there are studies showing that teachers' lack of knowledge in how to use materials (Babadoğan & Olkun, 2007; Keleş, 2009; Yenilmez & Çakmak, 2007) and lack of sufficient number of materials were major barriers to teaching transformational geometry, one of the most important findings of the present study is that there are not enough hands-on and technological materials in schools, neither are there computers and projectors in all the classes. According to the participating teachers, in order to teach transformational geometry effectively, material and technology usage is a needed. The participants maintained that when a school's physical facilities were not suitable, it was difficult to implement transformational geometry. In the literature, several studies are consistent with the results of the present study. For example, the teachers who participated in a study by Keleş (2009) claimed that they experienced difficulties during their teaching practices owing to lack of material and physical environments. In another confirming study conducted by Kalender (2006), what was most frequently emphasized by the teachers was that the equipment and material to be used during instruction were not met.

Another finding of the present study in relation to resources is that teachers want to make use of technology, but they do not have the facilities to do so. The teachers participating in the study claimed that if they could explain transformational geometry by making use of technology, the topic could be more easily understood by the students. Thus, it has been concluded that if technology could be made use of, problems experienced regarding transformational geometry will be reduced and a higher level of success in transformational geometry can be reached. Participants pointed out the lack of technological materials such as computer and projector and that it was difficult to implement transformational geometry when they lacked the necessary facilities, materials, and the technology, as confirmed by other Turkish studies (e.g., Kartallıoglu, 2005; Yenilmez & Çakmak; 2007 Yılmaz, 2008). They suggested that the classrooms should be equipped with technological devices and that mathematics laboratories should be established (Yenilmez & Çakmak, 2007).

In addition to these, Olive (2000) stated that when teachers use dynamic geometry materials like computer programs, students can understand the topic more effectively. Very similar to this finding, in a survey study by Fendi (2007) aimed to define the proficiency levels of primary school teachers in technology use, it was found that all the teachers felt more or less the need to learn how to use technology in class. Different from the findings of the present study, a study by İşman (2002) on teachers revealed that teachers did not know computer programs (PowerPoint, Word, Excel) and did not use the projector, the computer, or the overhead projector.

In the current study, some teachers emphasized that using smart boards would be beneficial in the teaching of transformational geometry. They claimed that if smart white boards were installed into the classrooms, material and technological equipment needs would be met to a large extent. Teachers claimed that the use of smart boards could increase the students' level of attention, motivation and participation and, thus, decrease their negative attitude toward mathematics. The findings of the study revealed that the use of smart white boards at schools could decrease the problems experienced in transformational geometry. The advantage of the smart board most commonly quoted in related literature is that they increase students' level of motivation (Smith et al., 2005). In a study by Shenton and Pagett (2007), which supports the finding of the present study, it is stated that in interviews both teachers and students highlighted the positive impact of learning by means of the smart board upon student motivation. In the same study, it was stated that one teacher who taught the lesson utilizing the smart board described her students as being totally motivated, interested and focused.

Ersoy (2006) highlighted that the textbook was the most important resource for a teacher when a library or an Internet connection did not exist in the teaching context. Therefore, this study showed that more emphasis should be given to reviewing the textbooks by considering the teachers' views with special attention. Textbooks must be completely renewed. The participating teachers forecasted that geometry education would be successful, but they pointed out that the textbooks should be improved continuously. In addition, the participants observed that the textbook was not sufficient in many aspects: the content, examples, exercises were insufficient, and also there was a gap between the questions in the course book and those in SBS, which is a result confirming Çakır's (2006) study on 4th grade mathematics textbooks.

One other finding of the present study was that, according to teachers, the success rate in transformational geometry classes that were crowded was low. In this study teachers maintained that they needed to implement far more activities in transformational geometry lessons and that in order to provide visualization, the fewer students there were, the higher and the success rate would be. Furthermore, the participants pointed out that crowded classrooms were not suitable to implement activities especially in transformational geometry lessons. Moreover, how transformational geometry should be implemented in crowded classrooms is an important question that should be answered (Bal, 2008). In total, it can be suggested that teachers need less crowded classrooms in order to implement transformational geometry effectively. The curriculum studies on how to carry out instructional activities should be done according to the numbers of students in classrooms. Therefore, decreasing the number of students will increase the efficiency of the curriculum. Studies in literature also confirm this finding. Gömleksiz and Bulut (2007) found in their study that teachers having class sizes that were between 21 and 30 had significantly positive beliefs in respect to the objectives than the other teachers who taught 31-40 and 41-50 students in one classroom. Similarly, Keleş (2009) and Erbaş and Ulubay (2008) postulated in their study that it was difficult to lecture and implement activities in crowded classes and that the level of success in such classes were low.

According to the results of related research conducted in Turkey and other countries, the most common complaint of teachers is the lack of time for planning and instruction and the number of students in the classrooms (Constantinos et al., 2004; Ross et al., 2002). As mentioned in literature, it was also found in the present study that the time allocated to transformational geometry in the curriculum was not sufficient. According to the teachers participating in the study, increasing the time allocated especially to transformational geometry can decrease problems. The teachers recommended that curriculum makers of this topic make amendments in the curriculum. Therefore, increasing the time for mathematics education within the weekly program in the curriculum seems necessary for transformational geometry. If this increase is not possible, reorganizing the curriculum in a way that more time will be available for teachers and the implementation of subject matter is necessary. Ulubay’s (2007) study supports this finding. In addition, Keleş (2009) suggested in her study that the number of lesson hours allocated to mathematics be increased, which is parallel to the findings of the present study.

In the present study, the teachers claimed that the ministry did not sufficiently support them in relation to the newly added topics (such as transformational geometry) with which they had problems. They complained that when they experienced problems, they could not find any helpful resource or activity on the official website of the ministry, nor could they find any in-service training seminar organized by the ministry. The teachers suggested that a system be developed where they could easily reach an official of the ministry and solve their problems when they felt the need. The findings of the study, based on teachers' views, revealed that in the ministry should increase its support to teachers so that problems experienced in transformational geometry instruction can be minimized and so that the topic can be taught more effectively. Despite the fact that the necessity of training was documented, most studies indicated that when the newly added topics were taught, teacher training was generally underemphasized (Bal, 2008; Babadogan & Olkun, 2006; Bulut, 2007; Halat, 2007; Kartallıoglu, 2005; Yapıcı & Leblebiciler, 2007). These findings are in consistency with those reported in the studies of Keleş (2009) and Kalender (2006) in which it was stated that the ministry should support teachers.

According to teachers, objectives of transformational geometry are enough and clear in the mathematics curriculum of fifth grade to eighth grade. There is not any problem about objectives in curriculum. In the curriculum, transformational geometry is often emphasized. Besides, enough attention to the transformational geometry has been given in the curriculum. Curriculums of five to eight grades are given in the appendix B in order to show the objectives of transformational geometry.

5.4. Implications

Based on the findings of this study, several implications for teachers, teacher educators, curriculum developers, and the Ministry of National Education could be deduced.

First of all, by taking the findings of this study into consideration, the number of undergraduate mathematics methodology courses in faculties of education, departments of mathematics education can be increased and the content of the current courses can be increased and reorganized. In addition, if the time allocated in the curriculum can be increased so that teachers can implement more activities and have more problem questions solved in class, learning outcomes regarding transformational geometry can be improved. By taking into consideration the findings of the study, the curriculum makers can increase the time allocated to transformational geometry.

Also, curriculum developers, textbook authors and researchers could consider the present study while preparing guide books for teachers. In the curriculum, three lesson hours are devoted for this topic but it is not sufficient. In other words, the number of transformational geometry lessons allocated to these topics is important. Thus, the objectives of this topic and the lesson hours might be raised.

By making use of the findings of this study, mathematics teachers can become aware of the problems they may face regarding this topic. If teachers experience similar problems while teaching transformational geometry, they can overcome their problems by using the suggestions proposed in the study.

By taking into consideration the findings of this study, the Ministry of Education can become aware of the problems experienced by teachers, their deficiencies and the support they request. The findings of this study can also enable the Ministry of Education to acquire information about the revision of textbooks and what to pay attention to when doing so.

Furthermore, this study can enable the Ministry of Education to become aware of how serious the deficiencies of schools are and how important the use of technology is for teachers. Thus, the need for technological equipment may be met. The findings in the study regarding the smart white board can contribute to the ministry's taking action to distribute smart white boards to schools.

Finally, by taking the findings of the present study into consideration, the Ministry's support system via the Internet website, which teachers' request, can be realized and teachers can be supported. In this way, valuable contributions can be made to solve teachers' problems.

5.5. Recommendations for Further Studies

In the present study, the main purpose was to investigate middle school mathematics teacher's problems in transformational geometry instruction. Moreover, in the study, it was aimed to define the teachers' suggested solutions to overcome these problems. In this part, recommendations are suggested for further studies in the view of the findings.

Classroom sizes should try to be lowered since individual needs are important during transformational geometry instruction. Hence a similar study might be conducted by investigating the importance of class size in teaching transformational geometry.

Interviews were used as a means of data collection in this study. A similar study can be conducted by both interviewing and observing mathematics lessons by video-recording in order to compare teachers' views expressed in the interviews and their practices in the mathematics lessons.

This study mainly analyzed teachers' views on transformational geometry and hence a similar study might be conducted by investigating the students' views. Moreover, no study has been found on the relation between textbook questions and those in SBS. The findings regarding teachers' views on SBS in this study constitute a starting point for future studies.

This study was conducted only in urban schools in a single city, so it could be repeated in more than one city, village settings and also schools in district areas. The effects of certain factors might be compared in order to document the differences.

The current study was conducted on middle school mathematics teachers' problems concerning transformational geometry. Further research can be carried out on teachers' problems in other mathematics topics.

5.6. Last Words

According to my observations, the teaching of transformational concepts takes time and because there is not enough materials and technological equipment (such as computers), drawing shapes on the board will be very difficult and time consuming.

As a mathematics teacher, I have similar concerns like the ones expressed by the participants in this study. Since I worked in a tutoring office, I could not implement some activities to the best of my ability because of lack of materials and technological equipment, especially computers. Also, I completely agree with the participants that time is not enough in order to perform the requirements of the transformational geometry. Similar to the participants' views, I want curriculum developers to increase the number of transformational geometry lessons in order to decrease problems related to time and I also believe that the textbooks should be revised. In addition, to capture success in transformational geometry, technological tools are a must. Finally, the curriculum of the mathematics education departments should be including more courses on teaching mathematics in middle school.

REFERENCES

Akay, G. (2011). *The effect of peer instruction method on the 8^{th} grade students' mathematics achievement in transformation geometry and attitudes towards mathematics*. Master's Thesis .Middle East Technical University, Ankara, Turkey.

Altun, M. (2002). *İlköğretim ikinci kademede (6., 7. ve 8. Sınıflarda) matematik öğretimi*. Bursa: Erkam Matbaası.

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, 2006 from Http://www.cimt.plymouth.ac.uk/journal/default.htm.

Bal, P. (2008). *Yeni ilkögretim matematik ögretim programının ögretmen görüsleri açısından degerlendirilmesi* [The evaluation of new mathematics curriculum in terms of teachers' views]. *Adana Çukuova Üniversitesi Sosyal Bilimler Dergisi, 17,* 53-68.

Ball, D. L. (1988). *Unlearning to teach mathematics* (Issue Paper 88-1). East Lansing: Michigan State University, National Center for Research on Teacher Education.

Ball, D. L. (1990). Prospective elementary and secondary teachers' understanding of division. *Journal for Research in Mathematics Education, 21*(2), 132-144.

Baykul, Y. (2002). *İlköğretimde matematik öğretimi*, Ankara; Pagema Yayıncılık.

Baykul, Y. (2005). *İlköğretimde Matematik Öğretimi*, Ankara: Pegema Yayıncılık.

Bıkmaz, H. F. (2006). Yeni ilkögretim programı ve ögretmenler. *Ankara Üniversitesi ve Egitim Bilimleri Fakültesi Dergisi, 39*(1)*,* 99-116.

Binbasıoglu, C. (1981) *Özel öğretim yöntemleri*, Ankara: Kadıoglu Matbaası

Bouckaert, C. (1995). *Transformation geometry in primary school according to Michel Demal*. Retrieved November 25, 2010, from http://www.uvgt.net/GTcrem.pdf

Boulter, D.R. (1992).*The effects of instruction on spatial ability and geometry Performance* Unpublished master's thesis. University of Queen's,Ontario.

Boulter, D., & Kirby, J. (1999). Identification of strategies used in solving transformational geometry problems. *Journal of Educational Research,87*, 298-303.

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

Bulut, S. (2004). İlköğretim programı yeni yaklasımlar, matematik (1–5. Sınıf),*Bilim ve Aklın Aydınlığında Eğitim Dergisi*, 54-55.

Bruner, J. (1960). *The process of education*. Cambridge, MA: Harvard University Press.

Capraro, R. M. (2000). *Exploring the effects of attitude toward mathematics, gender and ethnicity on the acquisition of geometry content knowledge and geometric spatial visualization* (Unpublished doctoral dissertation). The University of Southern Mississippi, Mississippi.

Carraher, D. W. & Schliemann, A. D. (2007). Early algebra and algebraic reasoning. In F. K.Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 669-705). Charlotte, NC: Information Age Publishing.

Clements, D. H. & Burns, B. A. (2000). Students' development of strategies for turn and angle measure. *Educational Studies in Mathematics, 41*(1), 31-45.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions* (2nd ed.). Thousand Oaks, CA: Sage.

Crities, T.W. (1992), ‘’Skilled and less skilled estimators strategies for estimating discrete quantities’’, *Elementary School Journal, 92* (5), 601–619.

Crowley, M. (1987). The van Hiele model of development of geometric thought. In M.M. Lindquist & A. P. Shulte (Eds.), *Learning and teaching geometry*, *K-12*. 1987 Yearbook of the National Council of Teacher of Mathematics (pp. 1-16), Reston: VA.

Çakır, A. (2006). *The teacher opinions about the fourth grade mathematics textbooks in elementary schools*. Unpublished master’s thesis. Eskisehir Osmangazi University, Eskisehir, Turkey.

Çoban, A.(1989). *Ankara, Merkez Ortaokullarındaki Son Sınıf Öğrencilerinin Matematik Dersine İlişkin tutumları*.Master’s Thesis. Gazi University, Ankara, Turkey.

Dayak, E.(1998). *İlköğretim 5. Sınıf Matematik Ders Kitaplarının Eğitim–Öğretime Uygunluğunun Değerlendirilmesi*. Master’s Thesis.Marmara University, İstanbul, Turkey.

Desmond, N. S. (1997). *The geometric content knowledge of prospective elementary teachers* (Unpublished doctoral dissertation). The University of Minnesota, Minnesota.

Develi, M.H., & Orbay, K. (2003), İlkögretimde niçin ve nasıl bir geometri ögretimi, *Milli Egitim Dergisi* Kış *20031*(57), 57-72

Ding, L. & Jones, K. (2006). Teaching geometry in lower secondary school in Shanghai, China. *Proceedings of the British Society for Research into Learning Mathematics*, *26*(1), 41-46.

Dixon, J. K. (1997). Computer use and visualization in students’ construction of reflection and rotation concepts. *School Science and Mathematics,97*(7), 352-359.

Edwards, L. (1990). *Children's learning in a computer microworld for transformation geometry* (Unpublished doctoral dissertation). University of California, Berkeley.

Edwards, L. & Zazkis, R. (1993). Transformation geometry: Naïve ideas and formal embodiments. *Journal of Computers in Mathematics and Science Teaching,12*(2), 121-145.

Edwards, L. D. (1997). Exploring the territory before proof: Students' generalizations in a computer microworld for transformation geometry. *International journal of Computers for Mathematical Learning, 2*, 187-215.

Erbas, K., & Ulubay, M. (2008). Implementation of the new Turkish elementary education mathematics curriculum in the sixth grade: A survey of teachers' views. *The New Educational Review, 16*, 51-75.

Erduran, A., Tataroğlu, B. (2009). Comparison of science and mathematics teachers' views regarding use of smart board in education. *9th international educational technology conference (IETC2009),* Ankara, Turkey.

Ersoy, Y. (2003). *Matematik okur yazarlığı- I: hedefler, gelistirilecek yetiler ve beceriler.* Retrieved December 15, 2012, from http://www.matder.org.tr/index.php?option=com_content&view=article&catid=8:matematik-kosesi-makaleleri&id=65:matematik-okur-yazarligiiihedeflergelistirilecek-yetiler-ve-beceriler-&Itemid=38

Ersoy, Y. ve Duatepe, A. (2003).*Teknoloji destekli matematik öğretimi*, Ankara.

Ersoy, Y., (2006). The innovations in the mathematics curriculum for elementary schools: Aims, content and acquirements. *İlkögretim Online 5*, 30–44. Retrieved January 17, 2012 from: http://ilkogretimonline.org.tr/vol5say1/v5s1m4.pdf.

Faydacı, S. (2008). *İlköğretim 6. sınıf öğrencilerine geometrik dönüşümlerden öteleme kavramının bilgisayar destekli ortamda öğretiminin incelenmesi*. Master's Thesis. Gazi University, Ankara, Turkey.

Fendi, F. (2007). *İlköğretim öğretmenlerinin teknoloji kullanım yeterliliği*. Master's Thesis. Yeditepe University, İstanbul, Turkey.

Fidan, N. (1986). *Okulda öğrenme ve öğretme*. Ankara: Kadıoğlu Matbaası.

Franke, L., & Kazemi, E. (2001). Learning to teach mathematics: Focus on student thinking. *Theory into Practice*, *40*, 102-109.

Freudenthal, H. (1973). *Mathematics as an educational task*. Dordrecht, the Netherlands:Reidel.

Fuys, D., Geddes, D. & Tischler, R. (1988). The van Hiele model of thinking in geometry among adolescents. *Journal for Research in Mathematics Education*, *Monograph Vol 3*. NCTM. http://www.jstor.org/stable/749957

Glass, B. J. (2001). Implication of geometric transformations in the multiple dynamically linked representations. *Dissertation Abstract International*, *62*(3),951.

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report, 8*, 597-607.

Gömleksiz, M. N., & Bulut, _. (2007). An evaluation of the effectiveness of the new elementary school mathematics curriculum in practice. *Educational Sciences: Theory & Practice*, 7(1), 81–94.

Gözütok, F., D. (2006), *Öğretim İlke ve Yöntemleri*, Ekinoks Yayıncılık, Ankara.

Gürbüz, K. (2008). *İlköğretim matematik öğretmenlerinin dönüşüm geometrisi, geometrik cisimler, örüntü ve süslemeler alt öğrenme alanlarındaki yeterlilikleri.* Master thesis. Abant İzzet Baysal University,Bolu, Turkey.

Güven, B. (2012). Using dynamic geometry software to improve eight grade students'understanding of transformation geometry. *Australasian Journal of Educational Technology*, *28*(2), 364-382.

Hacısalihoglu, H., Mirasyedioglu, S., & Akpınar, A. (2004), *Matematik ögretimi*, Ankara: Asil Yayın Dagıtım.

Halat, E. (2007). Yeni ilkögretim matematik programı (1–5) ile ilgili sınıf ögretmenlerinin görüsleri. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi*, *9*, 63–88.

Harper, S. R. (2002). *Enhancing elementary pre-service teachers' knowledge of geometric transformations* (Unpublished doctoral dissertation). University of Virginia, Charlottesville, Virginia.

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

Hollebrands, K. F. (2003). High school students' understanding of geometric transformations in the context of a technological environment. *Journal of Mathematical Behavior, 22,* 55-72.

Hoong, L. Y. & Khoh, L. S. (2003). Effects of geometer's sketchpad on spatial ability and achievement in transformation geometry among secondary two students in Singapore. *The Mathematics Educator, 7*(1), 32-48.

Işık, A., Çiltaş, A., Baş, F.(2010). Öğretmen yetiştirme ve öğretmenlik mesleği. *Atatürk üniversitesi sosyal bilimler enstitüsü dergisi 2010 14* (1): 53-62.

Işık, C. (2008). The factors affecting the use of the mathematics textbook of the mathematics teachers at primary education (grades 6-8) and their expectations. *Kastamonu eğitim dergisi.2008 16*(1), 163-176.

İşler, I. (2008). *Teachers' perceived efficacy beliefs and perceptions regarding the implementation of the 2004 primary mathematics curriculum.* Master's Thesis. Middle East Technical University, Ankara, Turkey.

İşman, A. (2002). Sakarya ili öğretmenlerinin eğitim teknolojileri yönündeki yeterlilikleri. *The Turkish Online Journal of Educational Technology, 1*(1), 72-92.

Junius, P. (2002). *Cognitive engagement in integrating euclidean and non-euclidean geometry* (Unpublished doctoral dissertation). University of Northern Colorado, Colorado.

Kalender, A. (2006). *Sınıf Öğretmenlerinin Yapılandırmacı Yaklaşım Temelli Yeni Matematik Programı'nın Uygulanması Sürecinde Karşılaştığı Sorunlar ve Bu Sorunların Çözümüne Yönelik Önerileri*. Master's Thesis. Dokuz Eylül University,İzmir, Turkey.

Karakuş, Ö. (2008). *Bilgisayar destekli dönüşüm geometrisi ögretiminin ögrenci erisisine etkisi.* Unpublished master's thesis. Osman Gazi University, Eskişehir, Turkey.

Karakuş, F. (2010). Fraktal kart etkinliğiyle fraktal geometriye giriş. *İlköğretim Online, 9*(1), 1-6.

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.

Kavak, Y. (1986). *Eğitim Fakültelerindeki Öğretim Elemanlarının Yeterlikleri ve Eğitim İhtiyaçları* (Unpublished doctoral dissertation). Hacettepe University, Ankara, 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.

Keleş,Ö., Haser, Ç., Koç, Y. (2012). An investigation of primary teachers' and upper elementary mathematics teachers' views about the new elementary mathematics curriculum. *Gaziantep sosyal bilimler dergisi. 11*(3). 715-736

Kirby, J.R., Boulter D.R. (1999). Spatial ability and transformational geometry. *European Journal of Psychology of Education, 14*(2).283-294.

Knuchel, C. (2004). Teaching symmetry in the elementary curriculum. *TMME, 1*(1),3-8.

Law, C. K. (1991). *A genetic decomposition of geometric transformations* (Unpublished doctoral dissertation). Purdue University, Indiana, U.S.

McGee, M. G. (1979). Human spatial abilities: Psychometric studies and environmental, genetic, hormonal, and neurological influences. *Psychological Bulletin, 86*(5), 889-918.

Merriam, S.B. (2009). *Qualitative research. A guide to design and implementation.* San Francisco: Jossey-Bass

Miles, M.B. & Huberman, A.M.(1994). *Qualitative data analysis: An expanded sourcebook (2nd ed.).*Thousand Oaks: Sage.

Ministry of National Education [MoNE], (2004*). İlköğretim Okulu Matematik Öğretmenliği Yeterlik Taslağı, Temel Eğitime Destek Programı "Öğretmen Eğitimi Bileseni"* Ankara,Turkey.

Ministry of National Education [MoNE] (2005). *İlkögretim matematik dersi (1-5.Sınıflar) ögretimi programı*. [Elementary school mathematics curriculum and guide (grades 1-5)]. Ankara, Turkey: Author.

Ministry of National Education [MoNE] (2006). *İlkögretim matematik dersi (6-8.Sınıflar) ögretimi programı*. [Elementary school mathematics curriculum and guide (grades 6-8)] Ankara, Turkey: Author.

Ministry of National Education [MoNE], (2007*). İlköğretim matematik dersi öğretim programı 6-8. sınıflar: Öğretim programı ve kılavuzu.* [Elementary school mathematics curriculum and guide (grades 6-8)] Ankara,Turkey.

Ministry of National Education [MoNE], (2009a). *İlköğretim Matematik Dersi Öğretim Programları ve Kılavuzu: 1-5. Sınıflar*. Retriewed from April 23, 2012 from http://ttkb.meb.gov.tr

Ministry of National Education [MoNE], (2009b). *İlköğretim Matematik Dersi Öğretim Programları ve Kılavuzu: 6-8. Sınıflar.* Retriewed from April 23, 2012 from http://ttkb.meb.gov.tr

Ministry of National Education [MoNE], (2009c). *Ortaöğretim Geometri Dersi 9 ve 10. Sınıf Öğretim Programları.* Retriewed from April 23, 2012 from http://ttkb.meb.gov.tr

Ministry of National Education [MoNE], (2010). *Ortaöğretim Geometri Dersi 11. Sınıf Öğretim Programı.* Retriewed from April 23, 2012 from http://ttkb.meb.gov.tr

Ministry of National Education [MoNE], (2011). *Ortaöğretim Geometri Dersi 12. Sınıf Öğretim Programı.* Retriewed from April 23, 2012 from http://ttkb.meb.gov.tr

Monk, D. H.(1994) *Subject Area Preparation of Secondary Mathematics and Science Teachers and Student Achievement*. (ERIC Document Reproduction Service No: ED487878.1994).

Moustakas, C. (1994). *Phenomenological research methods.* Sage Publications, Inc.

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

Olkun, S. ve Toluk, Z. (2003).*Matematik öğretimi*, Ankara: Anı Yayıncılık.

Olkun, S. ve Toluk, Z. (2006), *İlköğretimde Matematik Öğretimine Çağdaş Yaklaşımlar*, Ekinoks Yayınevi, Ankara.

Olson, M., Zenigami, F. & Okazaki, C. (2008). Students' geometric thinking about rotations and benchmark angles. *Mathematics Teaching in the Middle School,* 14, 24-26. http://www.nctm.org/publications/article.aspx?id=20780

Orbey, S. (2007). *Evaluation of the mathematics curriculum for elementary schools through the points of view of teachers* [İlköğretim matematik dersi öğretim programının öğretmen görüşlerine dayalı olarak değerlendirilmesi]. Unpublished master's Thesis. Onsekizmart University, Çanakkale, Turkey.

Özdaş, A., Tanışlı, D., Köse, N.Y. ve Kılıç, Çiğdem (2005). *Yeni ilköğretim matematik dersi (1-5. sınıflar) öğretim programının öğretmen görüşlerine Dayalı olarak değerlendirilmesi* [Evaluation of the new mathematics curriculum for elementary schools (1-5th Classes) through the points of view of teachers, reflections in education VIII: The symposium of evaluation of the new curricula for elementary schools]. *Eğitimde Yansımalar VIII: Yeni ilköğretim Programlarını Değerlendirme Sempozyumu, 14-16 Kasım,* Kayseri: Erciyes Üniversitesi Sabancı Kültür Sitesi.

Özen, H. (2006) *Türkiye'de Etkili Matematik Öğretimi İçin 1968-2005 Yılları Arasında Geliştirilen İlköğretim (1-5) Matematik Programlarının İncelenmesi.*Unpublished Master Thesis. Yüzüncü Yıl University, van, Turkey.

Özyürek, R.(2002). Kız ve erkek öğrencilerin on birinci sınıf öğrencilerin kariyer yetkinlik beklentisi, kariyer seçenekleri zenginliği, akademik performans ve yetenekleri arasındaki ilişkiler. Türk Psikolojik Danışma ve Rehberlik Dergisi, 17, 19-32.

Patton, M. Q. (2002). *Qualitative research and evaluation methods (3rd edition)*. Thousand Oaks, California: Sage Publications.

Pesen, C. (2003). *Matematik Öğretimi*. Ankara: Nobel Yayın Dağıtım.

Peterson, J. C. (1973). Informal geometry in grades 7-14. In K.B. Henderson (Ed.), *Geometry in the mathematics curriculum: Thirty-sixth yearbook.* (pp. 52-91).Washington, (ERIC Document Reproduction Service No: EJ090197).

Pleet, L. J. (1990). *The effects of computer graphics and mira on acquisition of transformation geometry concepts and development of mental rotation skills in grade eight* (Unpublished doctoral dissertation). Oregon State University,Oregon.

Polwolsky, K. (2006), *Transformation geometry*, Hofstra University.

Rollick, M. B. (2009). Toward a definition of reflection. *Mathematics Teaching in the Middle School*,14(7), 396-398. Retrived from: http://www.nctm.org/eresources/view_media.asp?article_id=8696

Ross, J. A., Hogaboam-Gray, A. & McDougall, D. (2002). Research on reform in mathematics education, 1993 – 2000. *Alberta Journal of Educational Research 31*(2), 13-24.

Ryan, T. G., & Joong, P. (2005). Teachers' and students' perception of the nature and impact of large-scale reforms. *Canadian Journal of Educational Administration and Policy, 38.* Retrieved October 30, 2006, from http://www.umanitoba.ca/publications/cjeap/articles/ryan_joong.html

Schwab, J. (1978). *Science, curriculum, and liberal education: Selected essays.* Chicago: University of Chicago Press. (Original work published 1961)

Shenton, A.& Pagett, L.(2007). From 'bored' to screen: the use of the interactive whiteboard for literacy in six primary classrooms in England Literacy, *41* (3), 129-136.

Shulman, L. S. (1986). *Those Who Understand; Knowledge Growth In Teaching.* (ERIC Document Reproduction Service No: EJ330821).

Shulman, L. S. (1987) *Knowledge and Teaching: Foundations of The New Reform.* (ERIC Document Reproduction Service No: EJ351846).

Smith, H, J., Higgins, S., Wall, K. & Miller, J.(2005). Interactive whiteboards: boon or bandwagon? A critical review of the literature. *Journal of Computer Assisted Learning, 21*, 91-101.

Soon, Y. P. (1989). *An Investigation of Van Hiele-like Levels of Learning in Transformation Geometry of Secondary School Students in Singapore* (Doctoral dissertation). The Florida State University, Florida.

Suydam, M. (1985). The shape of instruction in geometry: some highlights from research. *Mathematics Teacher, 78*(6), 481-486.

Sahin, K. (2006). *İlköğretim Öğretmenlerinin Eğitime-Öğretme Yeterlilikleri*. Master's Thesis, Gazi University, Ankara,Turkey.

Taşdemir, C. (2009). Elementary second level students' attitude to the Mathematics lesson: An example for bitlis city. *Dicle üniversitesi ziya gökalp eğitim fakültesi dergisi, 12* (2009), 89-96

Toptas, V. (2007). *İlköğretim matematik dersi (1–5) öğretim programında yer alan 1. sınıf geometri öğrenme alanı öğrenme öğretme sürecinin incelenmesi*.Master's thesis. Gazi University, Ankara, Turkey.

TTKB (2004). *Ilkögretim Matematik Dersi (1.-5. siniflar) Ögretim Programi.* Ankara:MEB Talim Terbiye Kurulu Baskanligi Yayinlari.

Turgut, M. & Yılmaz, S. (2007). Geometri derslerini anlatmaya nasıl başlardık: İlköğretim matematik öğretmen adaylarının görüşleri. *Üniversite-Toplum Dergisi*, 7(4).

Wesslen, M., & Fernandez, S. (2005). Transformation geometry. *Mathematics Teaching,191,* 27-29.

Yapıcı, M., & Leblebiciler, N. H. (2007).Teachers' views with regard to new elementary school curriculum. *Elementary Education Online*, *6*, 480-490.

Yazlık, D.Ö.(2011). *İlköğretim 7. sınıflarda cabri geometri plus II ile dönüşüm geometrisi*. Master's Thesis. Selçuk University,Konya,Turkey.

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.

Yılmaz, T. (2006). *Yenilenen 5.Sınıf Matematik Programı Hakkında Öğretmen Görüsleri*. Master's Thesis, Sakarya University, Sakarya,Turkey.

Zembat, Ö. (2007).Yansıma Dönüsümü, Dogrudan Ögretim ve Yapılandırmacılıgın Temel Bilesenleri. *Gazi Egitim Fakültesi Dergisi*, *27*(1), 195–213.

Wilson, S. M., Shulman, L. S., & Richert, A. (1987). 150 different ways of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.*), Exploring teachers' thinking* (pp.104-124). Susex, England: Holt, Rinehart & Winston.

APPENDICIES

APPENDIX A

Interview protocol

Sevgili meslektaşımız,

Ben Orta Doğu Teknik Üniversitesi İköğretim Matematik ve Fen Eğitimi bölümünde Yüksek Lisans yapmaktayım. Dönüşüm geometrisi konularının öğretimi sırasında karşılaştıgınız sorunlarınız ve bo sorunlarla baş etme yöntemleriniz hakkında görüşlerinizi öğrenmek istiyorum. İstediğiniz zaman görüşmeyi yarıda kesebilir, beğenmediginiz sorular hakkında görüş belirtmeyebilirsiniz. Kişisel bilgileriniz ve dönüşüm geometrisi konularının öğretimi sırasında karşılaştığınız sorunlarınız hakkında görüşleriniz kesinlikle gizli tutulacaktır.

Teşekkür ederim. Serap İLASLAN

ODTÜ Yüksek Lisans Öğrencisi

GÖRÜSME SORULARI

<u>Kişisel Bilgiler</u>

Kaç yıldır öğretmenlik yapıyorsunuz?

Daha önce nerelerde çalıştınız?

Hangi üniversiteden mezunsunuz?

Yaşınız:

1- Dönüşüm geometrisi, öteleme, yansıma, dönme ve ötelemeli yansımayı kısa olarak tanımlayabilir misiniz?

2- Dönüşüm geometrisinin ilköğretim matematik derslerinde yer alması ile ilgili ne düşünüyorsunuz?

-Dönüşüm geometrisi konusunu ve bu konuya yönelik öğretimi ve etkinlikleri ilk gördüğünüzde neler hissediyorsunuz ?

-Sizce öğrenciler için kolay mi, zor mu?Kolaysa neden, zorsa neden?

3- Ders işlenişinde yaşadığınız zorluklar nelerdir? Bu zorlukların nedenleri nelerdir?

-Bu zorlukların üstesinden gelebiliyor musunuz? Gelebiliyorsanız nasıl üstesinden gelebiliyorsunuz? Gelemiyorsanız neden üstesinden gelemiyorsunuz?

4-Size göre programın dönüşüm geometrisi ile ilgili kazanımları sınıf ortamında gerçekleştirilebiliyor mu? Gerçekleştiriliyorsa nasıl gerçekleştiriliyor, gerçekleştirilemiyorsa neden gerçekleştirilemiyor?

5-Dönüşüm geometrisi 5, 6, 7. ve 8. sınıf etkinliklerini uygularken zaman problemi yaşıyor musunuz? Öğretim programında (müfredatta) verilen süre yeterli mi? Yeterli değilse ne kadar süreye ihtiyacınız vardır?

6- İlköğretim matematik dersi öğretim programını (5-8. Sınıflar) incelediniz mi? İncelediyseniz öğretim programında dönüşüm geometrisi ile ilgili yeterli bilgi var mı? Yoksa neler eksik?

7- 5., 6., 7., ve 8. sınıf matematik ders kitaplarını/çalışma kitaplarını/öğretmen kılavuz kitaplarının dönüşüm geometrisi ile ilgili kısımları incelediniz mi? Sizce yeterli mi, yeterli değilse ne yapıyorsunuz ve nelerin olmasını isterdiniz?

8-Dönüşüm geometrisi kısmı ile ilgili derslere hazırlanırken hangi kaynakları kullanıyor sunuz? Bu kaynaklardan nasıl faydalanıyorsunuz? Bu kaynakların yeterliliği konusunda neler söyleyebilirsiniz?

9-Dönüşüm geometrisi kazanımları öğretiminde materyalleri (simetri tahtası, noktalı kağıt, cabri,matematiksel programlar) kullanıyor musunuz, kullanıyorsanız nasıl kullanıyorsunuz?Bu konuda yaşadığınız zorluklar nelerdir? Bu zorlukları aşmak için neler yapıyorsunuz?

10-Dönüşüm geometrisi etkinlikleri öğrencilerin bu konuyu öğrenmesini ne kadar sağlayabiliyor?

-Size göre dönüşüm geometrisi aktiviteleri öğrencilerin dönüşüm geometrisi becerilerini geliştiriyor mu, geliştiriyorsa nasıl geliştiriyor ? Geliştirmiyorsa neden geliştirmiyor?

- Size göre dönüşüm geometrisi konularını öğrenciler için gündelik hayatlarında kullanabilirler mi, kullanabilirlerse nasıl kullanabilirler?

11-Farklı derslerde (fen bilimleri,resim,v.s.) dönüşüm geometrisi kullanılıyor mu?

-Diğer derslerle dönüşüm geometri arasında bir ilişki var mı?Varsa nasıl bir ilişki var?

-Öğrencilerin dönüşüm geometrisi kazanımları ile farklı dersler(fen bilimleri,resim,v.s.) arasında ilişki kurmasını kolaylaştıracak birşey yapıyor musunuz, yapıyorsanız neler yapıyorsunuz? Yapmıyorsanız neden yapmıyorsunuz?

12-Dönüşüm geometrisi kazanımlarının öğretiminde öğrencilere ne gibi proje ve performans görevi veriyorsunuz?

-Bu ödevleri değerlendirirken zorluklarla karşılaşıyor musunuz? Karşılaşıyorsanız ne tarz zorluklarla karşılaşıyorsunuz? Bunların üstesinden gelebiliyor musunuz? Gelebiliyorsanız nasıl gelebiliyorsunuz? Gelemiyorsanız neden üstesinden gelemiyorsunuz?

13-Matematik dersi öğretim programının dönüşüm geometrisi konusunun öğretimine yönelik alanla ile ilgili bilgi becerilerinizi nasıl değerlendiriyorsunuz?

-Matematik programının dönüşüm geometrisi kısmının istenildiği şekilde uygulanabilmesi ile ilgili ne tip eğitimler aldınız, üniversitede hangi dersleri aldınız?Hizmetiçi eğitimlere katıldınız mı?

-Yaptıklarınızın size ne gibi katkıları oldu?

14-Eklemek istediginiz birşey var mı?

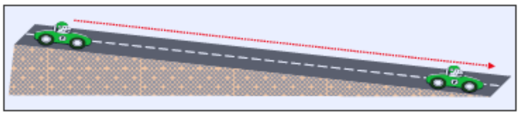
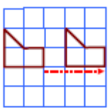
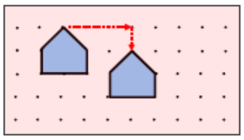
APPENDIX B

5-8 Mathematics Curriculums

6. SINIF GEOMETRİ ÖĞRENME ALANININ ALT ÖĞRENME ALANLARI VE KAZANIMLARI

G E O M E T R İ Ö Ğ R E N M E A L A N I		
ALT ÖĞRENME ALANLARI	KAZANIMLAR	TOPLAM
Doğru, Doğru Parçası ve Işın	1. Doğru ile nokta arasındaki ilişkiyi açıklar. 2. Doğru parçası ile ışını açıklar ve sembolle gösterir. 3. Bir doğru parçasına eş bir doğru parçası inşa eder. 4. Aynı düzlemdeki iki doğrunun birbirlerine göre durumlarını belirler ve sembolle gösterir. 5. Uzayda bir doğru ile bir düzlemin ilişkisini belirler.	**5**
Açılar	1. Açının düzlemde ayırdığı bölgeleri belirler. 2. Bir açıya eş bir açı inşa eder ve bir açıyı iki eş açıya ayırır. 3. Komşu, tümler, bütünler ve ters açıların özelliklerini açıklar.	**3**
Çokgenler	1. Çokgenleri inşa eder.	**1**
Eşlik ve Benzerlik	1. Eşlik ve benzerlik arasındaki ilişkiyi açıklar. 2. Eş ve benzer çokgenlerin kenar ve açı özelliklerini belirler.	**2**
Dönüşüm Geometrisi	1. Öteleme hareketini açıklar. 2. Bir şeklin öteleme sonunda oluşan görüntüsünü inşa eder.	**2**
Örüntü ve Süslemeler	1. Çokgenler ile çokgensel bölgelerin eş ve benzerlerini kullanarak örüntüler oluşturur. 2. Öteleme ile süsleme yapar.	**2**
Geometrik Cisimler	1. Prizmaların temel elemanlarını belirler. 2. Eş küplerle oluşturulmuş yapıların farklı yönlerden görünümlerini çizer.	**2**
	T O P L A M	17

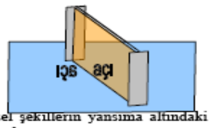
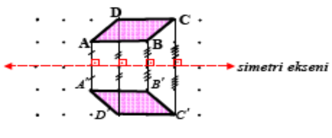
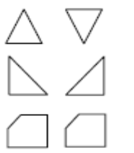
6. SINIF GEOMETRİ ÖĞRENME ALANI

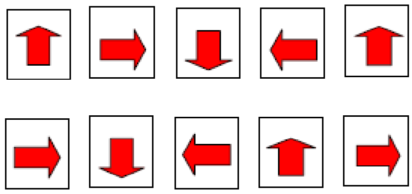
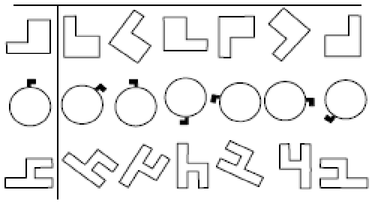
A.Ö.A.	KAZANIMLAR	ETKİNLİKLER	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	**1.** Öteleme hareketini açıklar.	Kaydırak veya kızakta kayan çocuğun, eğimli ve düzgün bir zeminde hareket eden oyuncak otomobilin, esintisiz bir havada göndere çekilen bayrağın, gergin bir ip üzerindeki boncuğun, sürgülü kapının, sabit vinç kovasının hareketlerindeki konum değişiklikleri incelenerek ötelemenin bir nesnenin bir yerden başka bir yere belirli bir doğrultu ve yönde kayma hareketi olduğu fark ettirilir. 	Öteleme hareketini içeren spor dalları hangileridir?
	2. Bir şeklin öteleme sonunda oluşan görüntüsünü inşa eder.	Kalemtıraş, silgi, kalem vb. malzemeler bir cetvelin kenarı üzerinde belirtilen birim kadar ötelenir.  Tangram parçaları veya kartondan hazırlanmış çokgensel bölge modellerinin yerleri; noktalı, kareli veya izometrik kâğıt üzerinde çizilerek belirlenir. Daha sonra bu modeller ötelenerek varılan yerde tekrar çizilir. Ötelemenin yönü ve doğrultusu ile kaç birim uzunluklu olduğu açıklanır. Noktalı, izometrik veya kareli kâğıtlar üzerinde çokgenlerin hangi yönde ve kaç birim öteleneceği belirtilerek görüntüsünün çizimini yapmak için bir başlangıç köşesi seçilir. Bu köşenin öteleme altındaki görüntüsü işaretlendikten sonra diğer köşeler için de aynı işlem tekrarlanır. Elde edilen noktalar birleştirilir.  **3 birim sağa öteleme**  **3 birim sağa 1 birim aşağıya öteleme**	[!] Ötelemede şeklin duruşunun, biçiminin ve boyutlarının aynı kaldığı vurgulanır. [!] Bir şeklin kendisiyle öteleme altındaki görüntüsünün eş ve simetrik olduğu ve bu tür simetriye ***öteleme simetrisi*** denildiği vurgulanır. [!] Dinamik geometri yazılımları kullanılabilir. [!]Ötelemenin farklı bir simetri türü olduğu ve doğru simetrisiyle karıştırılmaması gerektiği vurgulanır. Öteleme simetrisi ile doğru simetrisi arasındaki farkı ve benzerliği açıklayan bir paragraf yazınız. Eşlik ve Benzerlik

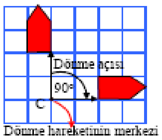
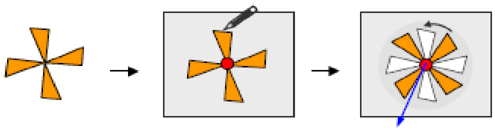
7. SINIF GEOMETRİ ÖĞRENME ALANININ ALT ÖĞRENME ALANLARI VE KAZANIMLARI

G E O M E T R İ Ö Ğ R E N M E A L A N I		
ALT ÖĞRENME ALANLARI	KAZANIMLAR	TOPLAM
Doğrular ve Açılar	**1.** Bir doğrunun üzerindeki veya dışındaki bir noktadan bu doğruya dikme inşa eder. **2.** Bir doğru parçasının orta dikmesini inşa eder. 3. Bir doğruya dışındaki bir noktadan paralel doğru inşa eder. **4.** Aynı düzlemde olan üç doğrunun birbirine göre durumlarını belirler ve inşa eder. **5.**Yöndeş, iç, iç ters, dış ve dış ters açıları belirleyerek isimlendirir. **6.** Paralel iki doğrunun bir kesenle yaptığı açıların eş olanlarını ve bütünler olanlarını belirler.	**6**
Çokgenler	**1.** Çokgenlerin köşegenlerini, iç ve dış açılarını belirler. **2.** Dörtgenlerin kenar, açı ve köşegen özelliklerini belirler.	**2**
Eşlik ve Benzerlik	**1.** Çokgenleri karşılaştırarak eş olup olmadıklarını belirler ve bir çokgene eş çokgenler oluşturur. **2.** Çokgenleri karşılaştırarak benzer olup olmadıklarını belirler ve bir çokgene benzer çokgenler oluşturur.	**2**
Çember ve Daire	**1.** Çemberin özelliklerini belirler ve çember modeli inşa eder. **2.** Çemberin düzlemde ayırdığı bölgeleri belirler. **3.** Çember ile doğrunun ilişkisini belirler. **4.** Çember veya dairede merkez açı ve çevre açı ile bu açıların gördüğü yayları belirler. **5.** Aynı yayı gören merkez açının ölçüsü ile çevre açının ölçüsü arasındaki ilişkiyi belirler.	**5**
Geometrik Cisimler	**1.** Dairesel silindirin temel elemanlarını belirler, inşa eder ve açınımını çizer. **2.** Yüzlerinin farklı yönlerden görünümlerine ait çizimleri verilen yapıları, birim küplerle oluşturur ve izometrik kâğıda çizer.	**2**
Dönüşüm Geometrisi	**1.** Yansımayı açıklar. **2.** Dönme hareketini açıklar. **3.** Düzlemde bir nokta etrafında ve belirtilen bir açıya göre şekilleri döndürerek çizimini yapar.	**3**
Örüntü ve Süslemeler	**1.** Çokgensel bölge modelleriyle bir bölgeyi döşeyerek süsleme yapar. **2.** Düzgün çokgensel bölge modelleriyle oluşturulan süslemelerdeki kodları belirler. **3.** Yansıma, öteleme ve dönme hareketleri ile süsleme yapar.	**3**
	T O P L A M	**23**

7. SINIF GEOMETRİ ÖĞRENME ALANI

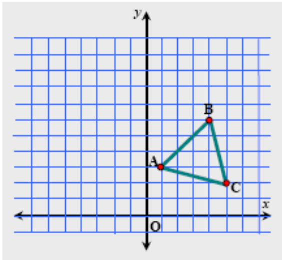
A.Ö.A.	KAZANIMLAR	ETKİNLİKLER	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	**1.** Yansımayı açıklar.	Masa üzerine tam açılmış kitabın sayfaları, suyun kenarında dik duran bir nesnenin kendisi ile sudaki görüntüsü, açılır kapanır çift kanatlı otomatik kapılar vb. model alınarak "yansımanın doğruya göre simetri (ayna simetrisi)" olduğu fark ettirilir. Ters yazılmış olan yazılar bir ayna yardımıyla okutularak aynadaki görüntünün yansıma olduğu, yansımada şeklin biçim ve boyutunun değişmediği, sadece şeklin yönünün ters çevrildiği ve yerinin değiştiği fark ettirilir.  Öğrenciler, düzlemsel şekillerin yansıma altındaki görüntülerini noktalı; izometrik veya kareli kâğıtlara çizerler.  ABCD paralelkenarının simetri eksenine göre yansıtılmasından sonra $A'B'C'D'$ paralelkenarı olarak bulunur.	[!] Dinamik geometri yazılımları kullanılabilir. [!] Şeklin kendisi ile yansımasının eş olduğu vurgulanır. [!] Bir şeklin simetriği oluşturulurken şeklin üzerindeki her noktadan simetri eksenine dik inilip uzatıldığı ve eksenin diğer tarafında bu noktanın eksene eşit olan uzaklığındaki nokta işaretlenerek simetrik noktanın bulunduğu hatırlatılır. Ambulans taşıtının önündeki "AMBULANS" yazısının niçin ters yazıldığını açıklayınız. Aşağıdakilerden hangisi yansıma simetrisine sahiptir? a) b) c)  Eşlik ve Benzerlik

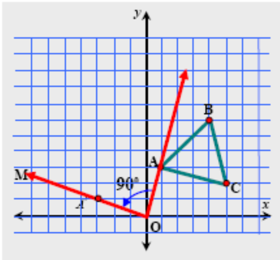
A.Ö.A.	KAZANIMLAR	ETKİNLİKLER	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	2. Dönme hareketini açıklar.	Saatin yelkovanı, rüzgâr gülü, salıncak, yelpaze, pervane, kapı ve pencere kolundaki hareketler gözlemlenerek dönme hareketinin bir çember hareketi olduğu fark ettirilir. Patates baskı yaptırılarak dönme hareketi gözlemlenir. 	[!] Döndürülen şeklin biçim ve boyutunun değişmediği, ancak şeklin duruşunun ve yerinin değiştiği vurgulanır. [!] Dönme hareketi ve dönmenin yönü sırasıyla, çember çizme ve çemberin çizim yönü ile ilişkilendirilir. Aşağıda çizginin sağında verilen şekillerden hangileri çizginin solunda verilen şekillerin döndürülmüşüdür? 

A.Ö.A.	KAZANIMLAR	ETKİNLİKLER	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	**3. Düzlemde bir nokta etrafında ve belirtilen bir açıya göre şekilleri döndürerek çizimini yapar.**	 Kareli kâğıt üzerine çizilmiş düzlemsel şekil, C noktası etrafında (saatin yönünde) 90° döndürülerek çizimi yapılır.  Şekil, A noktası etrafında (saat yönünün tersine) 180° döndürülerek (noktaya göre simetri) çizimi yapılır. **Aşağıdaki şeklin kâğıttan modeli kesilir. Kesilen model, merkezinden raptiye ile kâğıda tutturulur ve kâğıt üzerine sınırları çizilir. Model, saat yönünün tersine döndürülerek çizimiyle (kendisiyle) hangi açılarda çakıştığı belirlenir.**  **Dönme hareketinin merkezi** **Dönme sırasında şeklin kendisiyle çakıştığı açıların 360°'den küçük olduğu vurgulanarak böylesi şekillerin, *dönme simetrisi*ne sahip şekiller olduğu keşfettirilir.**	**[!] Saatin akrep ve yelkovanının bağlı olduğu pimin, rüzgâr gülündeki pimin, salıncakta oturağı taşıyan iplerin veya zincirlerin bağlandığı yerin dönme hareketinin merkezi olduğu keşfettirilir.** **[!] Yelkovanın ilk durumu ile son durumunun oluşturduğu açıya "dönme açısı" denildiği belirtilir.** **[!] Çeyrek dönmenin 90° lik dönme, yarım dönmenin 180° lik dönme olduğu vurgulanır.** **[!] 180° lik dönmenin merkezil dönme (noktaya göre simetri) olduğu açıklanır.** **[!] Bir şekil kendi merkezi etrafında döndürüldüğünde 360° den küçük açılı dönmelerde en az bir defa kendisi ile çakışıyorsa bu şeklin *dönme simetrisi*ne sahip olduğu vurgulanır.** **[!] Dinamik geometri yazılımları kullanılabilir.** **Kare, dikdörtgen, eşkenar üçgen, düzgün beşgen ve düzgün altıgenin hangi dönme açılarında dönme simetrisine sahip olduğunu bulunuz.**

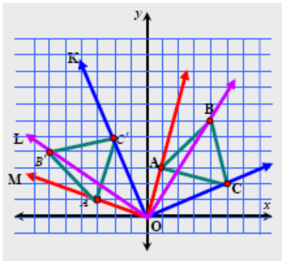
DÖNÜŞÜM GEOMETRİSİ

Aşağıda verilen ABC üçgenini orijine göre saat yönünün tersine 90° döndürerek $A'B'C'$ üçgeni olarak görüntüsü buldurulur.





Orijinden ve A noktasından geçen $\overline{OA}$ çizdirilir. $\overline{OA}$ ile saat yönünün tersinde 90°'lik açı yapacak biçimde $\overline{OM}$ ışını çizdirilir. $\overline{OM}$ ışını üzerinde $\overline{OA}$'ya eşit uzunluk işaretlenerek A' köşesi elde edilir.

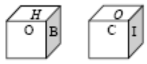
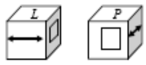
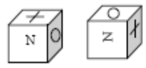
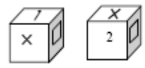
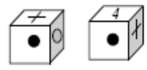


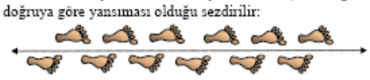
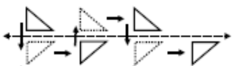
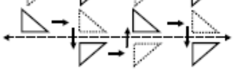
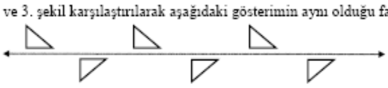
$\overline{OL}$ ve $\overline{OK}$ üzerinde B' ve C' köşeleri aynı yöntemle elde edilir.

Döndürülen noktalar birleştirilerek $A'B'C'$ üçgeni elde edilir.

8. SINIF GEOMETRİ ÖĞRENME ALANININ ALT ÖĞRENME ALANLARI VE KAZANIMLARI

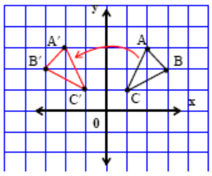
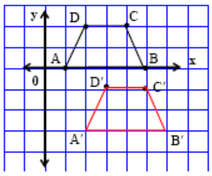
GEOMETRİ ÖĞRENME ALANI		
ALT ÖĞRENME ALANLARI	KAZANIMLAR	TOPLAM
Üçgenler	1. Atatürk'ün matematik alanında yaptığı çalışmaların önemini açıklar. 2.Üçgenin iki kenar uzunluğunun toplamı veya farkı ile üçüncü kenarının uzunluğu arasındaki ilişkiyi belirler. 3. Üçgenin kenar uzunlukları ile bu kenarların karşısındaki açıların ölçüleri arasındaki ilişkiyi belirler. 4. Yeterli sayıda elemanının ölçüleri verilen bir üçgeni çizer. 5. Üçgende kenarortay, kenar orta dikme, açıortay ve yüksekliği inşa eder. 6. Üçgenlerde eşlik şartlarını açıklar. 7. Üçgenlerde benzerlik şartlarını açıklar. 8. Pythagoras (Pisagor) bağıntısını oluşturur. 9. Dik üçgendeki dar açıların trigonometrik oranlarını belirler.	9
Geometrik Cisimler	1. Prizmayı inşa eder, temel elemanlarını belirler ve yüzey açınımını çizer. 2. Piramidi inşa eder, temel elemanlarını belirler ve yüzey açınımını çizer. 3. Koninin temel elemanlarını belirler, inşa eder ve yüzey açınımını çizer. 4. Kürenin temel elemanlarını belirler ve inşa eder. 5. Bir düzlem ile bir geometrik cismin ara kesitini belirler ve inşa eder. 6. Çok yüzlüleri sınıflandırır. 7. Çizimleri verilen yapıları çok küplülerle oluşturur, çok küplülerle oluşturulan yapıların görünümlerini çizer.	7
Örüntü ve Süslemeler	1. Doğru, çokgen ve çember modellerinden örüntüler inşa eder, çizer ve bu örüntülerden fraktal olanları belirler.	1
Dönüşüm Geometrisi	1. Koordinat düzleminde bir çokgenin eksenlerden birine göre yansıma, herhangi bir doğru boyunca öteleme ve orijin etrafındaki dönme altında görüntülerini belirleyerek çizer. 2. Geometrik cisimlerin simetrilerini belirler. 3. Şekillerin ötelemeli yansımasını belirler ve inşa eder.	3
İz Düşümü	1. Bir küpün, bir prizmanın belli bir mesafeden görünümünün perspektif çizimini yapar.	1
	TOPLAM	21

A.Ö.A.	KAZANIMLAR	ETKİNLİK ÖRNEKLERİ	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	**2.** Geometrik cisimlerin simetrilerini belirler.	Öğrenciler: **1.** Küp ve dikdörtgen prizmanın; **a.** Karşılıklı iki yüzlerinin paralel olan kenarının orta dikmelerinden ve paralel olan yüz köşegenlerinden geçen düzlemlere göre simetrik olduklarını, **b.** Karşılıklı yüzlerin merkezlerinden geçen doğrular ve her bir köşegenleri etrafındaki 180^0 lik dönmelerde değişmez kaldığını, **2.** Dairesel silindirin; **a.** Ekseni etrafındaki her bir dönmede değişmez kaldığını, **b.** Ekseninden geçen düzlemlere ve ekseni dik olarak ortalayan düzleme göre simetrik olduğunu, **3.** Dönel dairesel koninin, ekseni etrafında her bir dönmede değişmez kaldığını ve eksenden geçen her bir düzleme göre simetrik olduğunu, **4.** Kürenin, her çapı etrafındaki dönmede değişmez kaldığını ve her bir çapından geçen düzlemlere göre simetrik olduğunu, **5.** Eşkenar üçgen, ikizkenar üçgen, kare, düzgün altıgen ve düzgün sekizgen piramitlerin; **a.** Eksenleri etrafında dönmelerin değişmez kaldığını, **b.** Simetrik düzlemler olduklarını uygun modelleri üzerinde gözlemleyerek ya da inşa ederek keşfederler.	[!]Küpün ekseni etrafındaki 90^0 lik dönmelerde değişmez kaldığı vurgulanır. [!]Düzgün beşgen, düzgün altıgen prizmaların simetrileri ile değişmez kaldıkları dönme ve dönme eksenleri, gereksinim duyulursa işlenir. [!]Eşkenar üçgen prizma ile eşkenar üçgen piramidin simetrileri ve dönmelerde değişmez kaldıkları belirlenir. Aşağıda bütün yüzlerinde harf, rakam veya şekil bulunan küpler verilmiştir. Küpler döndürüldüğünde hangi çiftler birbirinin aynısı olur? **a.**  **b.**  **c.**  **ç.**  **d.** 

A.Ö.A.	KAZANIMLAR	ETKİNLİK ÖRNEKLERİ	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	3. Şekillerin ötelemeli yansımasını belirler ve inşa eder.	Düz bir toprak yol boyunca çıplak ayakla yürüyen bir kimsenin ayak izleri model alınarak bir şeklin ötelemeli yansımasının, bir doğru boyunca ötelenip aynı doğruya göre yansıması olduğu sezdirilir: **1.**  **2.**  **3.**  2 ve 3. şekil karşılaştırılarak aşağıdaki gösterimin aynı olduğu fark ettirilir. **4.** 	[!]Ötelemeli yansımada hiçbir noktanın ve yansıma doğrusundan başka hiçbir doğrunun sabit kalmadığı vurgulanır. [!]Bir şeklin, bir doğru boyunca yansımasından sonra ötelenmişi ile ötelenmişinden sonra yansımasının aynı olduğu vurgulanır.

Sınıf-Okul İçi Etkinlik Okul Dışı Etkinlik [!]Uyarı Ders İçi İlişkilendirme Diğer Derslerle İlişkilendirme Ölçme ve Değerlendirme Ara Disiplinlerle İlişkilendirme
A.Ö.A.: Alt Öğrenme Alanı

8. SINIF GEOMETRİ ÖĞRENME ALANI

A.Ö.A.	KAZANIMLAR	ETKİNLİK ÖRNEKLERİ	AÇIKLAMALAR
DÖNÜŞÜM GEOMETRİSİ	**1.** Koordinat düzleminde bir çokgenin eksenlerden birine göre yansıma, herhangi bir doğru boyunca öteleme ve orijin etrafındaki dönme altında görüntülerini belirleyerek çizer.	Öğrenciler, koordinatları A(2,3), B(3,2) ve C(1,1) olarak verilen bir üçgenin *y* eksenine göre yansıma altındaki görüntüsünü çizerler. (-1)x A(2,3) → A′ (-2,3) B(3,2) → B′ (-3,2) C(1,1) → C′ (-1,1) (x,y) → (-x,y)  Öğrenciler, koordinatları A(1,0), B(5,0), C(4,2) ve D(2,2) olarak verilen bir yamuğu *x* ekseninde 1 birim sağa, *y* ekseninde 3 birim aşağıya (veya *y* eksenine paralel 3 birim aşağıya, *x* eksenine paralel 1 birim sağa) öteleyerek görüntüsünü çizerler. + 1 A(1,0) → A′(2,-3) B(5,0) → B′(6,-3) C(4,2) → C′(5,-1) D(2,2) → D′(3,-1)  (x,y) → (x+a,y+b) (x,y) → (x+1,y+(-3))	[!]Doğruya göre öteleme yaptırılırken, *x* ve *y* eksenleri boyunca belirtilen yönde ve belirtilen birim kadar, bütün noktaların paralel öteleneceği vurgulanır. [!]Dinamik geometri yazılımları kullanılabilir. Cebirsel İfadeler Eşlik ve Benzerlik

İLKÖĞRETİM 1-5. SINIFLAR MATEMATİK DERSİ 5. SINIF ÖĞRETİM PROGRAMI'NIN ÖĞRENME ALANLARI,

Ö Ğ R E N M E A L A N L A R I		
S A Y I L A R	**G E O M E T R İ**	**Ö L Ç M E**
ALT ÖĞRENME ALANLARI	**ALT ÖĞRENME ALANLARI**	**ALT ÖĞRENME ALANLARI**
Doğal Sayılarla Çıkarma İşlemi	**Simetri**	**Zamanı Ölçme**
1. En çok beş basamaklı doğal sayılarla çıkarma işlemini yapar. 2. En çok dört basamaklı iki doğal sayının farkını tahmin eder ve tahminini işlem sonucuyla karşılaştırır. 3. Dört basamaklı doğal sayılardan 10'un, 100'ün ve 1000'in en çok dokuz katı olan doğal sayıları zihinden çıkarır. 4. Doğal sayılarla çıkarma işlemini gerektiren problemleri çözer ve kurar.	1. Çokgenlerin simetri doğrularını belirler ve çizer. 2. Düzlemsel bir şeklin verilen simetri doğrusuna göre simetriğini çizer. **Örüntü ve Süslemeler** 1. Düzgün çokgensel bölgeleri kullanarak ve boşluk kalmayacak şekilde döşeyerek süsleme yapar. **Düzlem** 1. Uzayı tasvir eder. 2. İki düzlemin birbirine göre durumlarını belirler.	1. Zamanı ölçme birimleri ile ilgili problemleri çözer ve kurar. **Sıvıları Ölçme** 1. Litre ve mililitre birimlerini birbirine dönüştürür. 2. Sıvı ölçme birimlerinin kullanıldığı problemleri çözer ve kurar. **Hacmi Ölçme** 1. Bir geometrik cismin hacmini standart olmayan bir birimle ölçer. 2. Aynı sayıdaki birimküpleri kullanarak farklı yapılar oluşturur.

APPENDIX C

TEZ FOTOKOPİ İZİN FORMU

<u>ENSTİTÜ</u>

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ■

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

<u>YAZARIN</u>

Soyadı: İLASLAN
Adı : Serap
Bölümü : İlköğretim Fen ve Matematik Eğitimi

<u>TEZİN ADI</u> (İngilizce) : Middle School Mathematics Teachers' Problems In Teaching Transformational Geometry And Their Suggestions For The Solution Of These Problems

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

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ■
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

Yazarın imzası Tarih 04.03.2013