THE EFFECT OF PEER INSTRUCTION METHOD ON THE 8th GRADE STUDENTS' MATHEMATICS ACHIEVEMENT IN TRANSFORMATION GEOMETRY AND ATTITUDES TOWARDS MATHEMATICS

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ABSTRACT

THE EFFECT OF PEER INSTRUCTION METHOD ON THE 8th GRADE STUDENTS' MATHEMATICS ACHIEVEMENT IN TRANSFORMATION GEOMETRY AND ATTITUDES TOWARDS MATHEMATICS

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The purpose of the research study is to investigate the effect of peer instruction method on the 8th grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students). Besides, in this study it was aimed to investigate the gender differences regarding mathematics achievement and mathematics attitude.

The study was conducted during the academic year 2009-2010. The sample was consisted of 112 eighth grade students from a public elementary school in Küçükçekmece district in Istanbul. Two classes, instructed by the researcher, were randomly assigned as experimental and control groups. The experimental group students were taught the subject transformation geometry through peer instruction method, while the control group students were taught the subject transformation geometry conventionally. Mathematics Achievement Test (MAT) and Attitude towards Mathematics Scale (ATMS) were administered to students as measuring instruments.

The two-way ANCOVA and two-way ANOVA statistical techniques were performed in order to answer to the research questions. Results indicated that the peer instruction method has significant positive effects on students' mathematics achievement and attitudes towards mathematics. Also, it was shown that there is not a significant difference between the female and male students' mathematics achievement and mathematics attitudes.

Keywords: Peer Instruction, Transformation Geometry, Mathematics Achievement, Attitude toward Mathematics

ÖZ

AKRAN ÖĞRETİMİ YÖNTEMİNİN SEKİZİNCİ SINIF ÖĞRENCİLERİNİN DÖNÜŞÜM GEOMETRİSİ KONUSUNDAKİ MATEMATİK BAŞARILARINA VE MATEMATİK DERSİNE YÖNELİK TUTUMLARINA ETKİSİ

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Bu çalışmanın amacı, akran öğretimi yönteminin sekizinci sınıf öğrencilerinin dönüşüm geometrisi konusu üzerinde matematik başarısı ve matematik dersine olan tutumlarına etkisini incelemektir. Bunun yanı sıra, bu çalışmada kız ve erkek öğrenciler arasında matematik başarıları ve matematiğe karşı geliştirilen tutuma ilişkin farklılık olup olmadığı incelenmiştir.

Bu çalışma 2009-2010 eğitim-öğretim yılında uygulanmıştır. Örneklem, İstanbul' un Küçükçekmece ilçesindeki bir devlet okulunun 112 sekizinci sınıf öğrencisinden oluşmaktadır. Araştırmacının dersine girdiği iki sınıf, deney ve kontrol grubu olmak üzere rastgele atanmıştır. Deney grubunda bulunan öğrenciler dönüşüm geometrisi konusunu akran öğretimi yöntemiyle işlerken, kontrol grubundaki öğrenciler geleneksel yöntemle ders işlemişlerdir. Ölçme aracı olarak Matematik Başarı Testi (MAT) ve Matematik Tutum Ölçeği (ATMS) kullanılmıştır.

Araştırma sorularını yanıtlamak üzere iki yönlü kovaryans analizi ve iki yönlü varyans analizi istatistik teknikleri kullanılmıştır. Analizlerin sonuçları, akran öğretimi yönteminin dönüşüm geometrisi konusunda öğrencilerin matematik başarısını ve matematiğe karşı olan tutumlarını olumlu yönde etkilediğini göstermiştir. Ayrıca sonuçlar kız ve erkek öğrencilerin, matematik başarıları ve matematiğe karşı tutumları arasında anlamlı bir fark olmadığını göstermiştir.

Anahtar kelimeler: Akran Öğretimi, Dönüşüm Geometrisi, Matematik Başarısı, Matematiğe Yönelik Tutum

To My Sister Pınar AKAY

&

To My Father and Mother

Bülent & Fatoş AKAY

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LIST OF ABBREVIATIONS

ANCOVA: Analysis of Covariance

ANOVA: Analysis of Variance

ATMS: Attitude towards Mathematics Scale

MAT: Mathematics Achievement Test

METU: Middle East Technical University

MoNE: Ministry Of National Education

NCTM: National Council of Teachers of Mathematics

PNG: Papua New Guinea

TIMSS: Trends in International Mathematics and Science Study

PLTL: Peer-Led Team Leader Model

RPT: Reciprocal Peer Tutoring

CHAPTER 1

INTRODUCTION

Geometry as a sub-learning area of mathematics has an important role in elementary mathematics (Gürbüz, 2008). According to the National Council of Teacher of Mathematics (NCTM, 2000) standards, 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 which improves students' reasoning and judgment abilities while proving the geometric theorems. In addition to these, Baykul (2005) stated that geometry is a learning area which entertains students and even makes them like mathematics while learning. He asserted that with the help of geometric shapes, while tearing, sticking papers or rotating, translating, reflecting the shapes, enjoyable games can be constructed. Also, he added that geometrical studies have an important role on enhancing students' critical skills and problem solving skills. According to Gürbüz (2008), geometrical thinking frame and the improvement of this frame is related to the instruction closely at the elementary level.

In order to educate qualified individuals, student centered teaching programs were designed with the studies of a committee which is formed by the Ministry of National Education, the Board of Education and Discipline at the beginning of 2004–2005 educational year (Gürbüz, 2008). As part of these changes some topics were added to the geometry content area. The newly added topics are transformation geometry, perspective drawing, fractals, tessellations and patterns (MoNE, 2007).

One of the newly added topic, transformation geometry has an important role in K-12 mathematics curriculum in the aspect of elementary school students' constructing understanding and interpreting the phenomena around them (Knuchel, 2004). Transformation geometry enforces the students to think three dimensional and to comprehend the movements such as rotation, reflection and translation in various shapes. Also, fractals as a sub-learning area of transformation geometry, has a prominence in natural sciences and offers the possibility of describing various formations such as mountains, clouds and brain tumors (Kröger, 2000).

Klein (1870) stated that the transformational geometry is the basic subject of learning geometry (as cited in Junius, 2002). However, literature showed that both students and instructors have difficulties in understanding the transformation topic since this is a little more abstract topic than the other topics (Harper, 2002). In other words, it has been observed that since transformation geometry is different from the mathematics and geometry topics that students have been used to study for years, they are having difficulties in comprehending it. Therefore, there is a need for different teaching methods (Boulter, 1992).

The importance of students' active role during learning has been stressed by various studies (Brown & Campione, 1986). Students' working together collectively as a method has been found as an alternative solution to the problems in a class (Maheady, Harper, Mallette & Karnes, 2004). In other words, Bishop (1985), Clement (1991) and Jaworski (1992) claimed that in order to provide effective learning, there should be an interaction among the students, the learning material, and the teacher (as cited in Leikin & Zaslavsky, 1997). This interaction has a significant role especially from a constructivist perspective.

Several research studies showed that various group working methods such as cooperative learning, collaborative learning, peer instruction, peer tutoring, have positive effects on both students' mathematics achievement and attitude (Brown 1993; Burke & Sass, 2006; Freemyer et. al., 1995; Slavin, 1980; Swing & Peterson, 1982). Hooker (2010) said that in order to get students know each other better and share their learning experiences, they can be put together in several other classes and it is helpful for students both in social and academic way. Peer instruction method, one of the group working methods and thought to be effective in the crowded classrooms, will be concern of this study.

The peer instruction method was generally defined as a method which peers help each other one-to-one, learning from each other, sharing their success for a common purpose (Graybeal & Stodolsky, 1985; Hooker, 2010; Mynard & Almarzouqi, 2006; Yardım, 2009). The first application of peer instruction method was at a mentally disabled students' school in England in 18th century (Yardım, 2009). The purpose was to make students learn better. Yardım (2009) added that until the end of 18th century, the application of peer instruction was decreased. Lindboe (1998) stated that one cannot see peer teaching method in the educational literature between the end of 19th century and 1960s, but it was used in rural areas because there was only one classroom for all grades at rural schools and older students in the class helped younger ones.

With the help of peer instruction method, students may suggest and encourage his/her ideas to improve performance without judgment (Hooker, 2010). Yardım (2009) asserted that since peer instruction increases the social interaction among students, it affects the attitudes of students positively. In peer instruction method while students are learning, they help other students' learning in similar social groups. According to Mazur's (1997) approach with peer instruction method lessons become environments in which students develop conceptual learning instead of information transfer sessions. In the same way Snider (2004) has shown peer instruction method as a teaching method which improves conceptual understanding and critical thinking. Besides, discussions among peers enhance friendship and motivate discussing the subjects every time. Although peer instruction method came up for problematic students, it is a beneficial method for all students (Yardım, 2009). According to Yardım (2009) the purposes of peer instruction method are to develop the skills of students, to provide self confidence in them and to support them while solving the problems they face.

Supportively, Hooker's study (2010) showed that after participating in the small peer-led collaborative groups, students' attitudes towards mathematics changed completely. He asserted that the group leaders enhanced their personal and academic skills and all the students started to spend much more time on mathematics in or out of class.

The importance and the effect of peer instruction method are mentioned above. Since peer instruction method enhances student interaction and is thought as a time saving and effective method in a class, its impact in mathematics classes should be examined.

1.1 Purpose of the Study

As mentioned above, transformation geometry and peer instruction are important concepts in the literature. Thus, in this study these concepts will be examined. More specifically, the purpose of the research study is to investigate the effect of peer instruction method and gender on the 8th grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

1.2 Research Questions and Hypothesis

1. What is the effect of peer instruction method and gender on the 8th grade students' mathematics achievement in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students) in Küçükçekmece district in Istanbul?

1.1 Is there a significant difference between 8th grade students' mathematics achievement scores who enrolled in peer and regular classroom instructions in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students)?

H_0: There is no significant difference between 8th grade students' mathematics achievement scores who enrolled in peer and regular classroom instructions in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

1.2 Is there a significant gender difference between 8th grade students' mathematics achievement scores in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students)?

H_0: There is no significant gender difference between 8th grade students' mathematics achievement scores in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

2. What is the effect of peer instruction method and gender on the 8th grade students' mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students) in Küçükçekmece district in Istanbul?

2.1 Is there a significant difference between 8th grade students' mathematics attitudes scores who enrolled in peer and regular classroom instructions in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students)?

H_0: There is no significant difference between 8th grade students' mathematics attitudes scores who enrolled in peer and regular classroom instructions in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

2.2 Is there a significant gender difference between 8th grade students' mathematics attitudes scores in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students)?

H_0: There is no significant gender difference between 8th grade students' mathematics attitudes scores in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

1.3 Definitions of the Important Terms

Peer instruction is defined as "children help children in a cooperative environment where the processes of teaching and learning interact" (Lindboe, 1998, p.19). In this study, peer instruction means an instructional method in which students study in groups of four and five rather than alone, sharing their knowledge face to face with the roles of tutor and tutee in the classroom towards a mutual goal of learning from a particular task.

Achievement is defined as "something accomplished successfully, especially by means of exertion, skill, practice or perseverance" (Thorndike & Barnhart, 1993). In this study achievement means the total measurement of the scores of mathematics achievement test prepared by the researcher. In another words, achievement is what the MAT measures.

Attitude is defined as "those beliefs formed from a combination of experiences measured in the domains of mathematics" (Capraro, 2000, p. 8). Generally, attitude towards mathematics refers to the feelings or manner of students towards mathematics lesson. In this study, attitude means the total measurement of the scores of attitude towards mathematics scale. In short, attitude is what the ATMS measures.

Transformational Geometry is defined as "a subset of geometry in which students learn to identify and illustrate movement of shapes in two and three dimensions. The three types of movement are slides (translations, as when a figure is moved on a page), flips (reflections, that is, when a figure is turned over in three dimensions), and turns (rotations, when a figure is rotated 90° without being flipped)." (Kirby & Boulter, 1999, p.285). In this study, transformation geometry includes the patterns such as fractals, and the motions of figures such as reflection, rotation, translation and combination of these.

1.4 My Motivation for the Study

I am a teacher in Istanbul and there are approximately 55 students in each classroom at my school. Last year while I was teaching transformation geometry I faced several difficulties. This topic did not make sense to the students. It was not easy for the students to comprehend it. Moreover, when I spoke with different mathematics teachers, I saw that they faced the same difficulties about this topic. Most teachers don't know how to teach this topic. Although it can be explained easily, fractal geometry, a sub-learning area of transformation geometry, leads to rich and interesting mathematical complexities and most of the teachers do not know exactly what it means. Teachers only give the information which textbooks present and give not more than two examples during the lesson. In my opinion, since this subject is a difficult and an abstract subject, it should be given importance and taught to students in an effective way. Students should experience different types of studies. Thus, it is believed that such a subject is worthwhile to study since it is new and has significant role in the elementary curriculum.

In addition to these, two of the questions that I asked myself are "How can I teach this topic better?", and "What should I give the students about this topic?”. Even though it is not easy to answer such questions, I will attempt to suggest an alternative way to the reader. During this, I thought that while teaching this topic, dividing the students into the groups, making them to discuss about the problems together as a group and making them more active in the classroom might help me to control the classroom easily since the class is crowded.

Lastly, I have decided on this topic because I want to make a study which has not been studied on much and practically will be beneficial for both students and teachers.

1.5 The Significance of the Study

Pleet (1990) asserted that geometry is considered to provide an opportunity to develop spatial-visual ability; so 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). The transformational geometry is really an important topic in the K-12 mathematics curriculum (Harper, 2002). However, the literature related to transformational geometry is constricted in Turkey. The elementary level educational aspect of transformational geometry especially fractals has not been studied a lot since it is a new topic in elementary education in Turkey and this may be the main significance for this study.

According to Desmond (1997), Edwards & Zazkis (1993), and Law (1991) both students and pre-service teachers have difficulties in understanding the reflection, rotation, and translation notions. Additionally, it is really difficult to study transformation geometry subject in crowded classes because it requires design work and drawings. Teacher may be insufficient for each student during the lesson. Boulter (1992) said that in order to provide conceptual understanding of students in transformational geometry topic, instructors must create an environment where the motions such as reflection, rotation and translation, can be simulated. Thus, it was asserted that alternative teaching methods should be used while teaching the topics of transformational geometry (Boulter, 1992). However, some teachers think that too much work, too much time and too much preparation will be needed for this and they again think that they cannot afford it (Niemi, 2002). At this point peer instruction method may be an alternative way for teachers.

Peer instruction method has been studied in different areas such as mathematics, science, statistics, and laboratory instruction and population education. However, in our country there are very limited studies conducted related to this method. In peer instruction method students can actively take part in the lessons. During direct teaching there may be many students who cannot take part in the lesson actively in crowded classes because if all the students are given a minute to talk it makes 50 minutes which makes more than a lesson. In this method, peers can control each other's drawings and solutions easily. They can discuss the topics and they can realize each other's mistakes easily. Also, this method requires minimal effort from teacher in crowded classrooms. Therefore the duration of the lesson (40 minutes) should be used in the best way with the peer instruction method as it might be a timesaving way to control only the groups. Thus, it would worth to investigate whether peer instruction method had significant effect on students' achievement and attitudes in transformational geometry.

CHAPTER 2

LITERATURE REVIEW

> …Geometry is grasping space. 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, p.403).

Develi and Orbay (2003) mentioned that the first inspiration sources of mathematics phenomenon are life and nature. Aside being used 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 science and art (Toptas, 2007). Geometry as a branch of mathematics covers everything around the world and it has a serious role in education, therefore it worths searching (Turgut & Yılmaz, 2007).

In this chapter firstly, transformation geometry topic as a sub learning area of geometry and the importance of geometry are examined. Afterwards, the place of transformation geometry in the new mathematics curriculum, research studies related to transformation geometry, and fractals as a sub learning area of transformation geometry are taken into consideration. Later on, mathematics attitude, mathematics achievement, and gender difference regarding mathematics achievement and attitudes are reviewed. Then, definitions, importance and details of peer instruction, and research studies related to peer instruction are mentioned. Lastly, the summary of literature review is given.

2.1 Importance of Geometry

Develi and Orbay (2003) asserted that geometry, one of the branches of mathematics can be associated to the nature easily. What the human beings have done for the geometry is to take the relationships more real and newer way by discovering the relation among the facts which already exist and are undeniable in the nature (Develi & Orbay, 2003).

Fidan (1986) stated that the geometry topics firstly gained the attention of people because of the necessity of breaking down a surface piece correctly. This caused the emergence of geometry which has the ability of measuring the objects and the shapes and also the ability of describing these numerically. Because of this, geometry has an important role for human beings' lives (Fidan, 1986). Also, according to Hvizdo (1992), since geometry makes us comprehend and appreciate the perspectives of the world around us, it can be called as a basic skill. As mentioned above, geometry offers us a great chance to interpret our physical environment, so geometry definitely has a crucial role in our lives. More recently, Atiyah (2002) wrote in order to make the importance of geometry obvious:

> Spatial intuition or spatial perception is an enormously powerful tool and that is why geometry is actually such a powerful part of mathematics – not only for things that are obviously geometrical, but even for things that are not. We try to put them into geometrical form because that enables us to use our intuition. Our intuition is our most powerful tool… (p. 30)

Malkevitch (1991) stated that no geometry teaching, except for Euclid Geometry, was encountered, even in education area, until the 19^{th} century. In this century, like other disciplines, geometry showed enormous improvement, too (Malkevitch, 1991). The separation of geometry into the different branches caused geometry to develop more than expected. As a result of this, Euclid Geometry became a subfield of the wide mathematics theories and today more than 50 geometry types can be mentioned about (Malkevitch, 1991).

Therewithal, instruction of geometry lessons and the curriculum plan of the geometry is the focus of international interest (Mammana & Villani, 1998). For example, Capraro (2000) claimed that all the properties and matters have a geometric shape and an individual should be aware of the relations between the properties in order to use them effectively. In the 1998 draft of the National Council of Teachers of Mathematics (NCTM) standards, it was mentioned that making the relationships obvious among the school geometry experiences and the real-world experiences makes it easier for students to improve required mathematics abilities and achievement in geometry (Capraro, 2000).

In recent decades geometry has widely taken place in the school curriculum in Turkey more than before as well as other countries in order to enhance students' visualization, thinking, mental ability, and analytical thinking ability (Gürbüz, 2008). Baykul (2005) stated different reasons why geometry takes part in mathematics education at elementary school level. Firstly, he mentioned that in mathematics studies at elementary school, critical thinking and problem solving take an important place. Geometry studies really contribute students' critical thinking and problem solving skills (Baykul, 2005). Secondly, he stipulated that geometry topics help to teach other topics in mathematics. For instance, while teaching the calculation techniques and the notions related to fractions and decimals; rectangles, squares and circular regions are mostly used. Thirdly, according to Baykul (2005) the other reason is that geometry can be used in daily life. For instance the shape of the rooms, buildings, the patterns used for ornaments are geometric. The fourth reason is the usage area of geometry. Geometry is used a lot in science and art. As for example, architects and engineers mostly use geometrical shapes; or in physics, chemistry and other science fields geometry is mostly used. Fifthly, geometry helps students to know the world they live in closely and to recognize its value. For instance, crystals or celestial bodies and their orbits are geometric shapes. Lastly, geometry is a tool to make students love mathematics and enjoy themselves. With geometrical shapes, cutting and pasting them, or by the help of rotation, translation or symmetry; enjoyable games can be played.

As stated above, teaching elementary school geometry topics is as important as teaching other topics (Turgut & Yılmaz, 2007). Therefore, the students' understanding of geometry is also important. Ding and Jones (2006) stated that in van Hiele model it was mentioned that 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 What is Transformation Geometry?

The study of transformation geometry as a sub learning area of geometry consists of the motions such as translation, reflection and rotation (Karakuş, 2008; Pleet, 1990). According to Klein (1870), the transformational geometry is the basic subject of learning geometry (as cited in Junius, 2002).

Similarly, Boulter (1912) mentioned that transformational geometry consists of mental, graphical or physical motions of two- or three-dimensional geometrical shapes. Motions can be listed like: slides (translation), flips (reflections), and turns (rotations) as given in *Figure 2.1* below (Boulter, 1992).

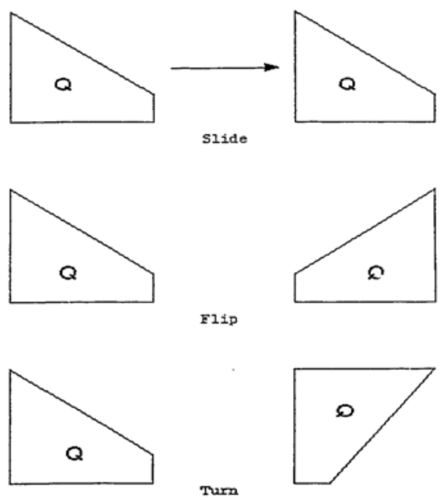


Figure 2.1 Simple rigid transformation (Boulter, 1992, p.4)

Beside the above expressions, Poincaré (1913) pointed out that geometry aims to study a particular group; and that general group concept preexists potentially in the mind of the individual. He asserted that there are mathematical group structures which are inserted in our minds. A mathematical group is a set which satisfies associatively, identity and inverse. The group structure idea which preexists in our minds may sound strange. However if you think groups as transformations such as rotations and reflections and if you connect them with Poincaré‘s (1913) notion of motor space and motion of solids as the true source of geometry it is more understandable (as cited in Junius, 2002).

The properties of geometric objects and properties of transformations shouldn't be thought independently from each other (as cited in Bouckaert, 1995). They should be considered to connect properties in order to provide gradual learning of how to prove. Moreover, it was added that the symmetries or automorphisms refer to a concept which is used to link the properties of objects to the properties of transformations and it means transforming an object into itself respecting its structure (as cited in Bouckaert, 1995). Transformation 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 provide discovering and/or proving properties of geometric objects; forming patterns like friezes, rosettes, wallpapers; classifying geometric objects; perceiving the chirality of an object (as cited in Bouckaert, 1995).

We could see the application of transformation geometry in many areas in the literature. Art and math go parallel with each other says Pumfrey and Beardon (2002). Knuchel (2004) stated that when looked at the tessellations, which were the products of Islamic civilization and brought to Europe by Arab conquests in the thirteenth century, the connection can be seen as they were a result of rotating, reflecting and sliding objects in a plane so that there are no gaps or overlaps. Pumfrey and Beardon (2002) asserted that tessellations are a common feature of decorative art and occur in the natural world around us. How patterns are made and how objects move in space are clearer with translations, reflections and rotations. Knuchel (2004) added, geometry and tessellation are taken to a higher standard by the all ideas presented in all mentioned articles. Thus, elementary level math curriculum shouldn't pass them up.

According to Gürbüz (2008), in transformation geometry learning area, students should be able to construct patterns by using equal polygonal regions and make tessellations with the activities of cutting, folding and sticking papers. Students discover the relationship among the geometric shapes by constructing, drawing, measuring, visualizing, comparing, changing the shapes and classifying them and they develop spatial intuition (Gürbüz, 2008).

California State Department of Education (1985) mentioned that in order to enhance the congruence, similarity, parallelism, symmetry and perpendicularity, geometric concepts, instruction in geometry should focus on using transformations of the plane such as reflections, translations, and rotations (as cited in Pleet, 1990). Similarly, Harper (2002) asserted that transformation geometry topic is an important topic which should be given part in the K-12 mathematics curriculum. Specifically for students between the 9th and 12th grades in solving geometric and non-geometric problems transformations should be a significant tool (Harper, 2002).

Knuchel (2004) added that for elementary school students, learning symmetry as a sub learning area of transformation geometry has a significant role because this provides them understand the things 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 by this area of geometry. It is important for students to comprehend the concepts of geometry and symmetry through the way which makes them think that everything they see around them has a strong foundation in mathematics, even if it is not directly related to it.

Boulter (1992) said that in order to provide conceptual understanding of students in transformational geometry topic, instructors must create an environment where the motions such as those in *Figure 2.1*, can be simulated. Further, he added that various teaching methods should be used while teaching the topic transformational geometry, in other words individual differences among students should be considered during this topic. Instructors should direct students and provide relations clearly, because it is important to constitute conceptual understanding and reasoning for students.

As mentioned above, the transformational geometry is really an important and required topic in the K-12 mathematics curriculum (Desmond, 1997). However, both students and pre-service teachers have difficulties in understanding the reflection, rotation, and translation notions (Desmond, 1997; Edwards & Zazkis, 1993; Law, 1991).

2.2.1 Importance of Transformation Geometry in the New Mathematics Curriculum

Many studies have revealed that students are not at the intended level in terms of education in Turkey (Karakuş, 2008). Thus, with the thought of bringing up qualified individuals by qualified teaching programs, the teaching programs were modified in accordance with student centered constructivist learning approach at the beginning of 2004-2005 educational year (Gürbüz, 2008). Gürbüz (2008) asserted that the new program of teaching mathematics was prepared with a cognitive approach and based on the principal of "every child can learn mathematics". The new program prepared with this approach and principal, aimed to form an educational atmosphere, where the student is mentally and physically involved, by taking the students' interests and needs into the center (Gürbüz, 2008). In this atmosphere, the aim is to develop students' different skills such as communication, implication and association (Gürbüz, 2008).

In the geometry area of mathematics there have been significant changes as well as other areas. Bulut (2004) mentioned some innovations in the program. One of them is content and process related to the students' life. Using teaching methods and techniques which provide students mental and physical activation, using equipments and concrete models facilitating meaningful learning of mathematics, teaching the meanings of the rules instead of memorizing them, using the activities which help students to see how mathematics works around them, in other courses or in mid disciplines are all the other innovations. Developing spatial skills and aesthetic feeling is also taken into consideration in the new program (Bulut, 2004).

One of the areas where the change has occurred is the transformation geometry topic. For instance, symmetry topic was started to be taught at the 7th grade in the old program. However, it is started to be taught at the 1st grade beginning with the intuitional level in the new program. In addition, pattern and tessellation topics, which were not included in the old program, take place at each grade in the new program (Gürbüz, 2008). In the program, the sub learning area of transformation geometry takes place from the 6th grade to the 8th grade. In addition to these, the new concepts which come up with the changes in transformational geometry are translation, reflection, translational reflection, rotation, pattern, and tessellation (MoNE, 2007). Translation requires sliding a shape on a ruler or on a dot paper to the right or left; up and down in a required amount; reflection requires reflecting an object according to a straight; and rotation requires turning of the shapes on a plane around a point according to an angle.

Since transformation geometry topic is new in the mathematics curriculum, as mentioned above; it is worthwhile to make a research on this topic (Karakuş, 2008).

2.2.2 Research Studies Related to Transformation Geometry

In the literature, there are some studies related to transformation geometry topic in Turkey or in other countries. Most of them have been conducted to reveal the relationship between spatial ability and transformation geometry. It is always expected that both fields relate each other. Suydam (1985) mentioned that 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 and using spatial processes. The strategies of solving transformational geometry problems can also be applicable for spatial tasks. 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 a research conducted by Gürbüz (2008), to determine the elementary school teachers' qualifications on the sub learning strands like transformational geometry, geometric objects, patterns and tessellations was aimed 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. When it comes to the gender difference, the female primary school teachers (57%) surpassed the male counterparts (33%) on the sub learning strands such as transformational geometry, geometric objects, pattern and tessellations.

Several research studies have been made on the teaching techniques of transformational geometry convenient for the class structure on account of the difficulties which were mentioned above. For example, Edwards (1997) stated that using microworld made it easier to construct a set of discernment and expectations related to the motion of geometric transformations. Besides, in another study carried out by Karakuş (2008), it was aimed to find how computer based learning effects the success of students in transformation geometry topic. In the experimental group, transformation geometry was taught via computer based learning while in the control group's lessons were activity based. A significant difference was seen between the experimental and the control groups.

Contrarily, according to the results of Boulter' s (1992) study, there was not a significant difference between the experimental group who took object manipulation, visualization and spatial process instruction and the control group who took traditional textbook-based instruction.

As it can be seen above, transformation geometry topic has not been studied a lot in Turkey; in other words there are limited research studies. In the next part, fractals, a sub-topic of transformation geometry, is mentioned.

2.2.3 Fractals

Fractal is the other interesting and exciting subtopic of transformational geometry for the students. Mandelbrot (1991) states that, describing the geometry of nature and the geometry of chaos are the two main roles of fractal geometry. Mandelbrot (1977) explains the origin of the term fractal as (p.1):

> I coined the term fractal from the Latin adjective *fractus*. The corresponding Latin verb *frangere* means "to break": to create irregular fragments. It is therefore sensible- and how appropriate for our needs! - That, in addition to "fragmented" (as in *fraction* or *refraction*). *Fractus* should also mean "irregular", both meanings have been preserved in fragment (as cited in Miller, 1998).

Actually, Briggs and Peat (1989) stated that, the first fractal shapes were identified over a hundred years ago (as cited in Miller, 1998). Strange shapes which could not be identified by the traditional Euclidean concepts of shapes and lines and calculus were constructed by using new recursive or iterative technique (Jones, 1993; Stewart, 1996). Because of these shapes, mathematicians panicked at the end of the nineteenth century (Jones, 1993) and shunned from these shapes said Miller (1998). Frame and Manderlbrot (2002) termed these shapes "monsters shapes" (p.12).

According to Bovill (1996) fractal geometry is the study of mathematical shapes which are never-ending, self similar, meandering cascade when observed closely. Also, Fraboni and Moller (2008) mentioned that fractals are self similar, that is to say fractal is a shape which consists of small copies of itself. This makes the fractals different and more appealing than the most Euclidean figures. They told that, Euclid's work is solid, consistent and timeless which has endured for 2000 years. But geometry is definitely not complete. In the table below comparison of Euclidean geometry and Fractal shapes are summarized (Pietgen & Saupe, 1988, p.26).

Table 2.1 Comparison of Euclidean Geometry and Fractal

EUCLIDEAN	**FRACTAL**
Traditional (>2000yr)	**Modern monsters (~10yr)**
Based on characteristic size	No specific size or scaling
Suits manmade objects	Appropriate for natural shapes
Described by formula	(Recursive) algorithm

Source: Pietgen & Saupe, 1988, p.26.

As mentioned in the Table 2.1, Euclidean Geometry exists for more than 2000 years but Fractal Geometry exists for approximately 10 years. Euclidean Geometry is based on characteristic size, suits manmade objects and can be described by formula while the fractal geometry has not got specific size or scaling, only appropriate for natural shapes and can be described by an algorithm.

In addition to the expressions above, Miller (1998) stated that fractal geometry is a lot richer than Euclidean geometry in terms of the lines, shapes, forms, patterns, and objects of nature when he compared the fractal geometry with Euclidean geometry. Further, Yazdani (2007) stated that fractal images are beautiful and astonishing and it is different from classical geometry. Classical or Euclidean geometry works for the development of mathematics, science, and engineering for centuries but when it comes to the ordinary events and shapes surrounding us it has failed. Complex rough objects, irregular lines such as mountains and clouds could not be explained by classical geometry. For instance, Mandelbrot (1977) mentioned that:

> Why is geometry often described as “cold” and “dry”? One reason lies in its inability to describe the shape of a cloud, a mountain, a coastline, or a tree. Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in straight lines (as cited in Miller, 1998).

As opposed to Mandelbrot, Galileo (1975) ignored nature's true shapes since they are irregular and therefore incomprehensible and he stated that (p. 241):

> Lines are called regular when, having a fixed and definite description, they are susceptible of definition and of having their properties demonstrated. Thus the spiral is regular, and its definition originates in two uniform motions, one straight and the other circular. So is the ellipse, which originates from the cutting of a cone or a cylinder. Irregular lines are those which have no determinacy whatever, but are indefinite and casual and hence indefinable; no property of such lines can be demonstrated, and in word nothing can be said about them (as cited in Miller, 1998).

As it is stated above, while Galileo is saying that irregular lines cannot be defined since they do not have any features, Mandelbrot has succeeded defining them and caused us to gain them. Thanks to Mandelbrot, with the invention of fractal geometry, it could be possible to explain the complex rough objects, irregular lines, forms, patterns as well as smooth ones such as coastlines, mountain ranges, tree branches, river-bed patterns, clouds, etc (Miller, 1998).

Similarly, Kröger (2000) mentioned that, in recent years the concept of fractal geometry has become famous in natural sciences and it is able to describe different phenomena as the shape of mountain, clouds, mixture of liquids, the description of turbulence, plant growth, the shape of brain tumors or lungs, models of economy, or the frequency of occurrence of letters and words. Also, Miller (1998) asserted, we are let to see the order and regularity in irregular objects by the fractal geometry just as chaos theory which states there is order and regularity in disordered systems.

Frame and Mandelbrot (2002) mentioned the importance of fractals in a class as below (p.12):

> …….fractal geometry is rich in open conjectures that are easy to understand, yet represent deep mathematics. First, they did not arise in earlier mathematics, but in the course of practical investigations in diverse natural sciences, some of them are old and well established, others are newly revived, and a few are altogether new. We feel very strongly that those fractal conjectures should not be reserved for the specialists, but should be presented to the class whenever possible.

Yazdani (2007) explained that natural objects such as ferns, coastlines, and mountains have formed more complicated geometric figures and to develop some curriculum materials infusing the concepts of fractal geometry in middle and high school mathematics curriculum is essential. According to him, students should be asked to explore various objects in nature which are not seemed to be formed of lines, circles, squares or triangles and students are engaged, motivated, persevered, and they make connections between mathematics and real life events during these activities. Frame and Mandelbort (2002) claimed that the study of fractals needs a little proof, but needs lots of simulation and visual displays. They thought that fractals can make mathematics interesting without breaking the rules of mathematical proofs.

Fraboni and Moller (2008) stated that presenting old ideas by using fractals, which is so recent, different and interesting, may bring new breathe to the classroom atmosphere. They also added that fractal geometry makes students gain a new perspective on their understanding and encourages creativity in problem solving. Students will examine some topics such as number sequences, symmetry, ratio and proportion, measurement, and fractions through fractal geometry. Also tools such as logarithms, composition of functions, Pascal’s triangle, arithmetic in different bases and complex numbers can be applied to fractal geometry at a higher level (Fraboni & Moller, 2008).

In addition to these, Fraboni and Moller (2008) stated that fractal geometry offers teachers great flexibility. Moreover, they added it can be adapted to the level of the audience or to time constraints. Although easily explained, fractal geometry leads to rich and interesting mathematical complexities (Fraboni & Moller, 2008).

The aims of a study which is conducted by Karakuş (2010) both to present an alternative way to provide students better understanding for the topic of fractals which is new in mathematics teaching program and design a technique for teachers which they can make use of in their classes. It is thought that this activity will help students discover the basic features of fractals that are repetition and self similarity (Karakuş, 2010). Besides students will have the opportunity of discovering different patterns in a concrete material. As a result of this activity, by working in groups, students will constitute a three dimensional fractal model and with the help of this model they will discover the features of repetition and self similarity which sets them apart from the shapes of Euclid Geometry.

As mentioned above, fractals are included in the new curriculum so to say it is applicable in the classes. The studies in the literature are generally about application of chaos theory, computer graphics, pattern recognition, physics or even music. Since fractals as a topic is new in the curriculum, there are a few, namely limited studies in the elementary education area. The other purpose of the present study is to investigate the effect of peer instruction method on the 8^{th} grade students' mathematics attitudes in crowded classrooms (more than 50 students). Thus, some information about the students' attitudes towards mathematics is given below.

2.3 Mathematics Attitudes

Mathematics attitude is defined as "those beliefs formed from a combination of experiences measured in the domains of mathematics" (Capraro, 2000, p. 8). Generally, attitude towards mathematics refers to the feelings or manner of students towards mathematics lesson.

In Iben's study (1991) with 979 Australian, 216 Japanese, and 549 American seventh- and eighth-grade public school students, the students' attitudes towards mathematics and its' relationship with mathematics achievement were investigated.

According to the study, the mathematics attitudes included (a) mathematics confidence; (b) extrinsic mathematics motivation-described as the desire to achieve mathematics awards and recognition; (c) mathematics as a male domain described as 'mathematics is a gender-neutral subject'; (d) mathematics usefulness; and (e) intrinsic motivation to study mathematics described as 'personal enjoyment' and 'pleasure in the study of mathematics' (p.138). The results of the study suggested that attitudes towards mathematics might be related to some stuff and one of them is mathematics achievement.

In TIMSS 2003 pilot research with 89 seventh grade participants, it was indicated that attitude to mathematics was related to mathematics achievement (Kadijevich, 2003). Similarly, Nyala (2008) mentioned that students' attitudes towards a subject affect their achievement in that subject. Beside the studies which mentioned above, mathematics achievement and attitudes regarding gender differences were taken into consideration in many studies.

2.4 Gender Difference Regarding Mathematics Attitudes and Achievement

Gender difference in mathematics learning is an important issue which is still being studied on by the researchers (Ercikan, McCreith, & Lapointe, 2005; Leder, 1992). Sells (1973) describes mathematics as a "critical fitler" because the lack of mathematical knowledge can hinder their having higher paying or prestigious occupations (as cited in Hyde, Fennema, & Lamon, 1990). As for these gender differences have been mostly focused on in many investigations. In the literature although some studies suggest that there is a significant difference between the male and female students' mathematics attitudes, some of them suggest that there is not a significant difference. Reports about National Assessment of Educational Progress-Mathematics in many newspapers and magazines appearantly show that males do better in mathematics. However, the validity and generality of this belief should be rechecked like many beliefs about differences between genders (Fennema, & Sherman, 1977).

In several studies, it was shown that male students have more positive attitudes towards mathematics than female students (Frost et al., 1994; Leder, 1995;

Nyala, 2008; Schofield, 1982; Shashaani, 1995). For instance, Thomson, Cresswell and De Bortolli (2004) stated that the studies on students' attitudes towards mathematics which measure the variables self-confidence, interest, enjoyment, self-efficacy and self-concepts showed that there is a significant gender difference that favors males. These studies' participants were both primary and secondary students. In these studies only for anxiety, females significantly surpassed males. According to Fennema, and Sherman (1977), girls do not feel encouraged to study mathematics. The reason for this is sometimes their ability and other times the social climate which they are exposed to (Fennema, & Sherman, 1977).

Thomson and Fleming (2004) stipulated that on account of mathematics anxiety and lack of confidence, girls underestimate their mathematical problem solving ability which causes female students to have a negative attitude towards mathematics. However; in spite of the findings about their low confidence in mathematics, classroom environment studies have indicated that girls' confidence in mathematics improved when they are actively involved in the learning of mathematics (Boaler, 1997; 2000; Rennie & Parker, 1997).

Interestingly, Dovona-Ope (2008) asserted that in many developing countries such as Papua New Guinea (PNG), many female students still encounter a number of difficulties in education that obstruct their improvement in a society that is anchored in various cultural practices, values and attitudes. A study of Yeoman (1987) brought out that girls' participation in education is strongly affected by parental attitudes. Parents in remote areas of PNG prefer educating their sons instead of their daughters since they do not want to take economical risks of girls' education. Also, this situation may cause negative attitude towards mathematics for female students. However, Dovona-Ope (2008) claimed that this negative attitude has started to change recently.

Supportingly, the findings of TIMSS 2003 pilot research study with eighty-nine 7th grade students presented that there was no gender difference in mathematics attitude (Kadijevich, 2003). Only for the statement "I need to do well in mathematics to get into the faculty of my choice", males agreed higher than females.

Similarly, Nyala (2008) showed that there was no gender difference between female and male students' attitudes towards mathematics at junior high school level. Eshun (1991) found no sex related difference at elementary school level as well because both females and males wanted to study elective mathematics at the senior secondary school (as cited in Nyala, 2008). This is also supported by Brush (1990), Sherman (1980), Heller and Parsons (1981) that in the primary school years girls' confidence in their ability is as much as boys'.

In an interesting way, it was claimed that female students in single-sex schools showed that they enjoyed studying the subject more than males and females in mixed schools, and males in single-sex schools (Nyala, 2008, p.154). Supportingly, Forgasz and Leder, (1996); Norton and Rennie, (1998) found that students have more positive attitude towards mathematics in single sex schools than students in the mixed schools. This shows that in such environments girls express their feelings freely and they reflect their needs easily (Nyala, 2008). This means that single sex environment is better for female students from an academic perspective and they get more benefit from such an environment.

In many studies, it was shown that male students succeeded better in mathematics than female students similar to the attitude findings. For instance, Fennema and Carpenter (1981) found out that males preceded females in the geometry and measurement as a result of an examination of the mathematics items from the 1978 National Assessment of the Educational Process. Fennema and Carpenter (1981) asserted that spatial visualization could be the reason of this gender differences because males' spatial scores have always been higher than females (Ben-Chaim, Lappan, & Houang, 1988; Tartre & Fennema, 1995).

Besides the consistent findings which were mentioned above; there are some inconsistent findings. For example, Fennema (1974) asserted that during early elementary years there is no significant difference between boys' and girls' mathematics achievement. Sometimes during upper elementary and early high school years significant differences are not apparent, either.

Similarly, the results of the TIMSS cross-national study indicated that up to grade 8 there is no considerable gender difference in achievement. Sixteen countries participated in the study and at the advanced mathematics level, 5 of them provided an almost total disappearance of gender difference in achievement (Hanna, 2003).

As can be seen in the literature, gender differences are not consistent. While some studies favor males, others claim that there is no difference. In this respect one of the aims of this study is to investigate whether there is a significant gender difference on the 8th grade students' mathematics achievement in transformation geometry (fractals, rotation, reflection, translation) and attitudes towards mathematics in crowded classrooms (more than 50 students).

2.5 Peer Instruction

In recent years, researchers formulate solutions to problems which occur in a class, by making students sit and work together as a group collectively (Maheady, Harper, Mallette & Karnes, 2004). In order to improve students' achievement, race relations, cooperative learning methods have been developed which provide students work in small and heterogeneous teams (Leikin & Zaslavsky, 1997). In the cooperative-learning classroom, students work in groups of two or three to discuss topics, make brainstorming for common and shared goals (Johnson & Johnson, 1999; Schmuck & Schmuck, 1979; Sharan & Sharan, 1976). However, in the last two decades there is revived interest in peer teaching rather than cooperative learning (Lindboe, 1998). Although, several research studies related to the effects of cooperative learning were conducted, there is little known about the peer work groups in a regular classroom (Ros, 1993). Actually, Yardım (2009) mentioned that both "cooperative learning" and "pair learning" premises can be used for peer instruction. In many studies, peer learning, peer instructions, peer tutoring, cooperative learning, group working terms are already used interchangeably.

Lindboe (1998) stated that educational literature hardly mentions about peer teaching from the end of the 19th century till 1960s except for some rural areas where schools had only one classroom for all grades and older students in the class helped younger ones. At the beginning, peer instruction was generally used in teaching read-write and foreign language; afterwards it has extended to science and mathematics lessons (Yardım, 2009). Stodolsky (1984) said that there is some evidence that peer work groups are more popular in science and social studies than mathematics.

2.5.1 Definitions of Peer Instruction

The definition of peer instruction varies in the research, but the basis of all the definitions is the same- children help children cooperatively in a classroom in order to reveal a common product (Lindboe, 1998; Stodolsky, 1984).

To state differently, the purpose of the peer instruction is defined as to help students' particular problems, enhance the learning skills and help to gain self confidence (Yardım, 2009). Yardım (2009) added although this method was started to be used in order to provide help for problematic students, it is beneficial for all students. Here are descriptions of peer instruction.

Goldschmit (1976) defined the peer instruction that students teach other students who are at the same age and who have the same educational experience. Further, there is another explanation for peer instruction method with which peers help each other one-to-one, learn from each other, and share their success for a common purpose (Graybeal & Stodolsky, 1985; Hooker, 2010; Mynard & Almarzouqi, 2006; Yardım, 2009). According to Lindboe (1998), peer instruction is a teaching strategy which includes cooperative interaction depending on the communication and trust (Lindboe, 1998). Beside all these definitions Hooker (2010) put forward a model, peer-led team leader model (PLTL), which integrates the aspects of small group learning, collaboration and peer learning. In PLTL workshop model there are extra two-hour sessions each week to allow a unique blend of teaching and learning methods. During workshop sessions which are arranged by the course instructor, students as a group of 6 to 8 can actively take part in the tasks such as discussion, problem solving and debate.

According to Lindboe (1998), with students working together and sharing their knowledge in small groups, peer instruction seems to take form of cooperative learning at the primary and secondary level. Yardım (2009) said that the programs which use cooperative learning and participating methods will consider the peer instruction method as an extension of their own approach. The basis of all terms is students' being encouraged to exchange ideas, revise their thinking and plan strategies to complete a task with their classmates as collaborators not as competitors (Lindboe, 1998; Slavin, 1987).

In addition these, peer instruction is defined as taking roles said Yardım (2009), one of the students has the role of instructor or the helper and one of the students has the role of being helped. However, Topping, Campbell, Douglas and Smith (2003) used similar definition while defining peer tutoring: "Peer tutoring is characterized by specific role-taking: at any point someone has the job of tutor or helper, while the other (or others) are in role as tutee(s)." (p. 292). Beside this definition, Topping (1996) defined peer tutoring as "more able students helping less able students to learn in co-operative working pairs or small groups carefully organized by a professional teacher." (p.322). Further, Topping (1996) added that the more developed peer tutoring is the broader definition has come out; "people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by teaching" (p. 322). Also, according to Pease (2000), peer learning is done in groups of the close aged children, often among siblings or cousins who have relation (as cited in Hooker, 2010).

In the present study, peer instruction refers to an instructional method in which students study as groups of four and five rather than alone, sharing their knowledge face to face with the roles of tutor and tutee in the classroom towards a mutual goal of learning from a particular task.

2.5.2 Importance of Peer Instruction

For centuries educators have been using peer teaching in order to disseminate information to the large number of students by breaking them into small groups (Lindboe, 1998). The advantage of the small group is that it gives opportunity to every student to be included (Hooker, 2010). Another reason for dividing the students into smaller groups is to let them help each other and learn through collaboration (Webb & Mastergeorge, 2003). Understanding one another's mathematical ideas is provided by mathematical communication in discourse practices like reasoning, argumentation, conjecture, and proof (Lerman, 2000).

Similarly, Jones (1993) points out that if students appreciate the different perspectives and different ways of mathematics, it may be helpful for improving their understanding. Students are provided with means to form their knowledge and opportunity to evaluate, communicate, listen, explore and discover by a classroom which supports cooperative learning between peers. Hooker (2010) said that in order to get to students know each other better and share their learning experiences, they can be put together in several classes and it is helpful for students both in social and academic way. Beside all these, this may provide teachers have an idea about how their students think and learn mathematics (Linboe, 1998; Simon, 1995).

It was also emphasized that students who are connecting with each other and their teacher through conversations in cooperative groups in a classroom is the best learning community (Mumme & Sheperd, 1990). At this point Tinto (1998) added that "The more students are involved in the social and academic life of an institution, the more likely they are to learn and persist" (p. 2). Also, Allen and Crosbie-Burnett (1992) supported this idea in the same way. They claimed that by the help of such interactive approaches students have a chance to make connections with each other and it may direct students to make discoveries of knowledge which is applicable to their lives. The outcome of it is that the group is more than the total of its parts, and they have higher academic performance than when they work individually (Johnson & Johnson, 1999).

According to Johnson and Johnson (1999) cooperative work with peers, have positive effects on psychological health, self-confidence and social proficiency. According to Hooker (2010), one reason of this could be the collaboration offers a free area without fear of failure or criticism where the students put out their abilities. Other students may suggest and encourage his/her ideas without judgment to improve performance (Hooker, 2010). The peers, since they are at the same age or at the same level of understanding, may help and learn from each other and they may know why they misunderstood or why they did in that way. A peer may explain the concepts with more easy terms that their peers understand (Hooker, 2010; O'Donnell, 2006; O'Donnell & O'Kelly, 1994). According to Leikin and Zaslavsky (1997) working with experts facilitates problem solving. Therefore, novice members of a group are led by expert members in order to gain experience.

In the same way, it was claimed that in peer instruction model while students help the learning of the other students who belong to the similar social group, they can also learn, all the students in a group receive mutual benefit (Anderson & Boud, 1996; Hooker, 2010; Yardım, 2009). Also, Riessman (1990) stated that peer resource programs, whether they are cooperative learning groups or one-on-one peer tutoring, are the most effective when each person involved in experiences both in the tutor and the tutee role. Interestingly, several researchers thought that the most efficient way to learn information is to teach it to another person (Bargh & Schul, 1980). In the same way, Webb (1989) consistently pointed out in a series of studies on peer interaction and learning that the one who gives detailed explanations to others in a group is the student who benefits most. Further, Rittschof and Griffin (2001) claimed that getting prepared in order to teach something to someone and giving elaborate definitions encourage conceptual configuration. Also it was stated that the higher initial achievement/ability student has, the more detailed explanations he/she tends to give. Similar positive learning effects of giving explanation have been found by other researchers (Chi & VanLehn, 1991; King, 1990; Swing & Peterson, 1982). It was emphasized that when working independently or competing with peers, these positive effects could not occur (Johnson & Johnson, 1999).

In short, Hairul and Joyce (2005) listed the effects of peer instruction as; (a) enhances conceptual skills, (b) improves tutor and tutee academically and socially, (c) enhances helpers' personal skills. According to some other researchers, peer teaching is the most effective for helper and the helpee when integrated with other teaching and learning methods (Goldschmid & Goldschmid, 1976; Whitman, 1988).

2.5.3 Details of Peer Instruction and Teacher Role

According to Lindboe (1998), for students, in order to work successfully with their peers there should be clear communication, good listening skills and motivated cooperation. Yardım (2009) mentioned two types of peer instruction. One of them is "cross peer instruction" where students who are more talented, teach others, the other one is “reciprocal peer instruction” where students always change the roles of instructor and student. Similarly, Graybeal and Stodolsky (1985) classified peer work groups as: (a) task structure: cooperative (students of the same level of ability solve a task together) and helping (one students helps another student), (b) reward structure: cooperative (students have to produce a solution or paper together), competitive (rewards of the students or the groups are negatively dependent of achievement of other students/groups) and individualistic (each student is rewarded independently of the achievement of other students).

In peer learning another important part is the formation of groups (Ashman & Gillies, 1997; Ros, 1993). Forming the groups can be done by different criteria. The first one is ability groups. Webb and Cullian (1983) formed both homogeneous and heterogeneous ability groups. Students who need help in homogeneous groups could not always get help. In addition to these, Cohen (1994) added that the use of heterogeneous groups is the most advocated one since it is hypothesized that it is beneficial for low achieving students to receive instruction from high achieving students or it is believed to increase the trust and friendship between members of different social groups. Moreover, Swing and Peterson (1982) and Bennett and Cass (1988) focused on the interaction in mixed ability groups in peer learning. As a result, there is an active participation among the students in heterogeneous groups (low and average achievers/average and high achievers). The second criterion is age which is related to ability. Graziano, French, Brownell and Hartup (1976) claimed that mixed aged groups are participated more in the tasks, and Johnson, Johnson, Pierson and Lyons (1985) also found that mixed-age groups are more motivated. The third criterion is gender. For instance, Morine-Dershimer (1985) showed that girls are more cooperatively oriented than boys. The last group criterion is group size. Because of the dispersion of responsibilities it can be more difficult for students to coordinate their activities in larger groups (Webb, 1989). However, in larger groups the possibility of at least one student can help another student is bigger. Therefore, larger groups are assumed to be more favorable, while the smaller groups are assumed more favorable for cooperation (Ros, 1993).

While examining the expressions above, the importance of interaction in the classroom stands out. The interaction among individuals can develop learning in various ways. In a group learning context students need to talk to present their ideas, to ask questions, to inform, to make suggestions etc (O'Donnell & King, 1999). Thinking aloud to the group itself is a mean of making process even if there is no response. Individual's knowledge structures can be changed by thinking aloud. It also makes individuals clear up and assess their own ideas and their existing knowledge and accuracies and gaps, integrate and reorganize knowledge or reconceptualize the material (Bargh & Schul, 1980; Brown & Campione, 1986). This change affects the following learning and performance. On the other hand, Ros (1993) mentioned that because of the interaction of students', the noise can have bad effects such as hindering the students from doing their work, and making it difficult to concentrate on the task for students; or because of the noise and the seating methods, it can be more difficult to control the students and activities for teachers.

Hertz-Lazarowitz (1989) pointed out three types of interaction which can be seen in peer work groups: (a) Cooperation: on-task interaction among students who are working together (their relation is based on equality), (b) Helping: one student's explaining in response to another student's need for help, (c)-Non-task related interactions: interactions that have nothing to do with the task. Interaction in verbal and nonverbal paralinguistic ways among learners can be provided by any peer learning context said O'Donnell and King (1999). Providing physical assistance, guiding another's skill physically or verbally, providing cues or hints to solve a problem and mutual discussion about the topic are various forms of interaction. According to Vygotskian perspective in learning, these social contexts develop individuals' cognitive abilities since learning occurs during interaction and activity with others (O'Donnell & King, 1999).

Interaction provides individuals' engagement in the exchange of ideas, information, perspectives and attitudes (O'Donnell & King, 1999). The other benefit of interaction is the opportunity of modeling their patterns of reasoning, thinking strategies and problem solving skills on those of peers. Finally, knowledge, meanings and skills of each other is internalized by individuals and new knowledge and meaning is built by the peer (O'Donnell & King, 1999). Thus, from this social constructivist theoretical perspective, peers are said to be mediators of each other's learning (O'Donnell & King, 1999). Also, Slavin (1987) mentioned that with the help of group mates, students can be more motivated and they do not have to wait for the teacher when they have questions.

Interacting in cooperative discussion contexts often provides individuals recognize their own perceptions, facts, assumptions, values and general understandings of materials which are different from others who are in interaction with him (O'Donnell & King, 1999). Individuals often need to reconcile these differences. Understanding and meaning must be negotiated with each other. This negotiation of meaning and this construction of knowledge are occurred by talking on the concepts, defending the ideas, asking questions, hypothesizing, speculating and assessing suggestions for feasibility, revising plans, and in general reaching to agreement on meanings and plans such as brain storming (O'Donnell & King, 1999). As Cobb (1988) pointed out that such meaning negotiation makes individuals continuously reorganize and restructure their own knowledge and thinking process. Working alone wouldn't cause such cognitive change. Group members facilitate each other's learning by means of such interaction with a high level of discourse. But according to O'Donnell and King (1999) generally students do not engage in high level of discourse spontaneously. Unless they are canalized to it, learners usually do not work in detail on material (Britton, Van Dusen, Glynn & Hemphill, 1990; Spires, Donley & Penrose, 1990). They do not either spontaneously activate and use their relevant prior knowledge (Pressley, McDaniel, Turnure, Wood & Ahmad, 1987) or ask many thought provoking questions while discussing unless they get specific training in question asking (King, 1990). Actually, students in groups seem to be more focused on the right answer rather than facilitating each other's problem solving (Vedder, 1985) and problem solving in groups proceed at a concrete specific level and step by step rather than at an abstract level unless the teacher guide them how to interact (Webb, Ender & Lewis, 1986). Thus, students seem to interact with each other at a very basic level unless they learn specific skills of higher level discourse (O'Donnell & King, 1999).

At this point, Yardım (2009) and Nath and Ross (2001) have underlined that in order to perform high with peer instruction method, participants should be informed before the application. Nath and Ross (2001) concluded from their study that the students who were informed before the treatment scored over the students who were not, in both communicating and collaborating at the 2^{nd} to 6^{th} grades. Similarly, it was expressed in several other research studies that students who has taught, achieved better on tests than who has not taught (Allen & Feldman, 1973; Annis, 1983; Bargh & Schul, 1980; Benware & Deci, 1984; Swing & Peterson, 1982; Webb, 1980). For instance, Gillies (2000) found that, in a study conducted at the primary school, the students who were informed about the cooperative group behaviors behaved more cooperative and explained better for the clear and certain requirements than the students who were not informed. In short, teacher may give brief explanation before starting the treatment.

At this point, another important factor, *teacher's role* comes forward. According to Wagner (1982) "peer teaching refers to the concept of students teaching other students in formal or informal school learning situations that are delegated, planned and directed by the teacher"(p. 5). Thus, teachers have an important role in peer instruction and this role should be taken into consideration seriously. However, while researching the interactions among students and the effects of cooperative learning, researchers often neglect the teacher factor.

As far as it is observed, teachers are often considered as blocks before spontaneous interactions of students (Harwood, 1989). Cohen, Lotan and Leechor (1989) pointed out that the more supervision of teacher (giving instructions and clues, asking questions and maintaining order) the less percentage of students who interact and cooperate in peer work groups. Cohen (1994) concludes that teachers, who supervise more, reduce the likelihood of communication among the students. If a teacher feels that the completion of tasks is his responsibility, students will not take the responsibility of solving the problems (Ros, 1993). Moreover Topping, Campbell, Douglas and Smith (2003) highlighted that: "Feedback and praise might be of lesser quality but greater quantity than a busy class teacher" (p. 294).

Johnson and Johnson (1999) explained the teachers' missions during peer instruction as specifying objectives for the lesson, deciding on the size of groups, assigning students to groups, assigning the roles of the students, arranging the lesson materials, arranging the classroom, explaining the task and the independence, teaching required concepts and strategies, monitoring students' learning, assisting to the groups working together, increasing students' interpersonal and group skills, collecting each groups' data and evaluating students' performance. If the interaction period is constructed wisely, it becomes more effective (Cohen, Kulik & Kulik, 1982; Topping & Ehly, 1998).

In this part the several components of peer instruction and the role of teacher are mentioned and in the next part the research studies related to the peer instruction method in Turkey and around the world is discussed.

2.5.4 Research Studies Related to Peer Instruction

Several researchers have documented the relation between the communication within a pair or a group of learners and the level of learning of the individuals. several researchers claimed that various group working methods have positive effects on both students' mathematics achievement and attitude (Brown, 1993; Burke & Sass, 2006; Freemyer et. al., 1995; Slavin, 1980; Swing & Peterson, 1982).

In the literature there are many studies which indicate the positive effect of peer instruction on students' achievement. For instance, Freemyer, Ajamian and Lecuyer (1995) conducted a study to examine collaborative learning at Glendale Community College. Students were expected to solve the mathematics and science problems on the worksheets prepared by the instructor as a group during workshop hours different than the class hours. The results showed improvement on the student success and improvement on the student-student and student-teacher interaction.

Supportingly, some research findings claimed that the term peer tutoring as a type of cooperative learning is an effective strategy to increase the student success (Bargh & Schul, 1980; Burke & Sass, 2006; Greenwood et al., 1988; Jenkins & Jenkins, 1985; Sherman, 1991; Slavin, 1991). For instance, Webb (1991) fulfilled a meta-analysis of 17 studies on the effects of help on student achievement in classroom practice. She made segregation among the types of helping in peer work groups: giving detailed explanations to other student versus giving only the answer with no further explanation. She pointed that giving detailed explanation has a positive effect on achievement; however, lower level of help (asking for explanations and receiving no answer, or just being told the correct answer) is negatively related to achievement. Also off-task interactions have negative correlation with student achievement.

Another study which was conducted by Phillips and his friends (1993) combined the measurement related to the general class curriculum and peer instruction in 40 elementary mathematics classes to enhance mathematics success. According to the results, the students whose mathematics achievements were low and normal achieved higher with regard to the control group.

Fantuzzo, King, and Heller (1992) conducted a study as well which had 64 students who were risky in mathematics, between the ages of 9-11. The results showed that those students' mathematics achievement improved after using the reciprocal peer learning model.

In addition to these, peer instruction has also an impact on affective domain such as attitude confidence. For instance, according to a study conducted by Connelly (2010) although there was no change in academic achievement, class wide peer tutoring enhanced student motivation and promoted comprehension. Also according to the results of a study conducted by Swing and Peterson (1982) achievement and retention of high and low ability students was enhanced by the task related interaction but the achievement of medium ability students was not facilitated.

According to the results of Hooker's study (2010), students' attitudes towards mathematics changed completely after participating in the small peer-led collaborative groups. For example the group leaders enhanced their personal and academic skills and all the students started to spend much more time on mathematics in or out of the class (Hooker, 2010).

Robinson, Schofield and Wentzell (2005) performed peer instruction method on the behavioral acquisition of African students who live in America (as cited in

Yardım, 2009). They showed that the program have positive effects on African American and other minority students as well as white students. Mynard and Almarzouqi (2006) applied peer instruction method on the women during English lessons in the United Arab Emirates. In the study, participants consisted of three groups as tutors, tutees and instructors. The results showed positive effects of peer instruction. Tutors were benefited from the treatment of learning through teaching; tutees were benefited from the treatment of enhancing their self- confidence and English language aptitude.

In another study conducted by Topping, Campbell, Douglas and Smith (2003), the impact of cross-age peer tutoring was examined. Participants were thirteen 7-year-old and fourteen 11-year-old students in a rural primary school. The treatment lasted five weeks. The tutors fulfilled the Me-As-Learner Scale (MALS); with respect to both tutors and tutees, class teachers fulfilled Behavioral Indicators of Self-esteem Scale (BIOS) and then students fulfilled questionnaires about their feelings and attitudes towards mathematics. The study results showed that there was a significant difference between the tutors' MALS and BIOS scores and the tutees' BIOS scores. Further, with the help of this successful project both tutors and tutees' self esteem has increased and also it has provided interactive discussion about mathematics among children in increased quantity and quality.

In Linboe's study (1998) the effectiveness of peer instruction among low achieving undergraduate mathematics students was checked. According to the results peer instructors maximize their self-confidence by involving more in constructing their own knowledge.

Contrarily, there are some studies which offer no significant attitude difference between the students who were applied peer instruction method and who were not applied. For instance, in a study which consisted of two experiments on college students in the field of education (Experiment 1 with 97 graduates and Experiment 2 with 100 undergraduates) , the reciprocal peer tutoring (RPT) method was used to examine cooperative learning between pairs. Results showed that RPT did not improve the understanding of students when compared to individual study. Besides, RPT did not affect students' self-efficacy or students' anxiety level. Despite all these, participants reported that RPT was helpful for the course content (as cited in Rittschof & Griffin, 2001).

Same-age peer tutoring project using mathematical games was reported by Mallinson as well (see Topping and Bamford, 1998). There were twenty-five 10-year-old mixed ability students as an experimental group and there were twenty 10-year-old also mixed ability students as comparison group. Treatment continued in regular mathematics classes. The treatment lasted 6 weeks. In each pair there was a student reading well. The results showed that there was not significant attitude difference towards mathematics.

In addition to these studies above, Stodolsky (1984) found that in American and British schools, cooperative working groups do not occur frequently and lots of children may never have the experience of working with their peers on elementary school academic subjects. Similarly, according to some research studies, peer work groups are not frequently used in US and European countries like Netherlands (Graybeal & Stodolsky, 1985; Ros, 1993). Ros (1993) stated that the 6 percent of Dutch elementary school teachers mentioned that peer work groups are used frequently in mathematics classrooms, 7 percent in language classrooms, and 30 percent in science classrooms. However, 35 percent of the instructors allow students to help each other in mathematics classrooms (Ros, 1993).

Similarly, in Turkey it is not common to use peer instruction method in classes. Therefore, there are not research studies enough in the literature related to this topic. Tokgöz (2007) from Turkey investigated the effect of peer instruction on students' physics achievement and attitude towards the science lesson. According to the results of the study, peer instruction had a greater effect on students' science achievement and retention than conventional instruction but according to the statistical analysis there was not a significant difference between the attitudes of students instructed conventionally and by peer. Further, Yardım (2009) from Turkey searched the effect of peer instruction method on 9th grade students' attitudes and manners towards the mathematics lesson. The results showed that this method not only enhanced the mathematics achievement but also improved the behavioral and social acquisition.

In some research studies the effect of peer instruction method on female and male students separately is taken into consideration as well. According to some research studies about the gender difference in collaborative groups claim that girls benefit most from the groups which have equal numbers of male and female students (O'Donnell, 2006). However, Tudge (1992) discovered that girls who are working in the same gender pair regress more than boys who are working in the same gender pair. Besides, girls tend to obey the males in the group no matter whether boys are minority or majority in the group (Webb, 1984; Webb & Palinscar, 1996).

However, according to the results of the study which was reported by Mallinson as mentioned above boys' scores were higher than girls (see Topping & Bamford, 1998).

2.6 Summary of the Literature Review

To sum up, the importance of geometry in elementary education cannot be denied. Transformation geometry as a subtitle of geometry is new in the curriculum and it is really a beneficial subject for the students' interpreting the phenomena around them as mentioned above. However; since there are limited numbers of studies related to the elementary level transformation geometry topic especially fractal geometry, this topic will constitute the main theme of the present study.

Small group learning as a teaching method has revived in the past 15 years (Ros, 1993; Swing & Peterson, 1982; Webb, 1991). The importance of peer instruction which is popular in recent years is emphasized above. In the literature, most of the findings showed that there is a significant positive effect of peer instruction method on students' achievement and attitudes towards the lessons and subject. However, most of the studies are related to different courses other than mathematics or different areas other than transformation geometry and there are limited studies related to this method in Turkey. Also, in Turkey classrooms are mostly too crowded and it is thought that this method would be an effective method in crowded classrooms when the features and the place of it in the literature are examined. Thus, this study is conducted to investigate the effect of peer instruction method and gender on the 8^{th} grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students).

CHAPTER 3

METHODOLOGY

This chapter is devoted to information about the research design, population and sample, data collection instruments, reliability and validity of the study, data collection procedure, analyses of data, assumptions, limitations, and lastly the internal and external validity of the study.

3.1 Design of the Study

The purpose of the research study is to investigate the effect of peer instruction method on the 8th grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students). Moreover, in this study it is aimed to investigate the gender differences regarding mathematics achievement and mathematics attitude. In this study, the static-group pretest-posttest design was used in this study (Fraenkel & Wallen, 2006). The design of the study is given in the below figure.

Groups	Pretest	Treatment	Posttest
Experimental Group	O	X	O
Control Group	O		O

Figure 3.1 The static-group pretest-posttest design

As mentioned in the *Figure 3.1*, in this study two already existing, or intact groups were used, one of them as the experimental group and one of them as the control group.

Both groups were measured twice; the first one served as the pretest (before the treatment) and the second as the posttest (after the treatment). Data were collected at the same time for both groups.

3.2 Population and Sample

All the 8^{th} grade students in Istanbul were identified as target population of this study. The 8^{th} grade students in Küçükçekmece district in Istanbul were the accessible population for this study and the two already existing classes of the 8^{th} grade students at Tayfur Sökmen Elementary School in Küçükçekmece district were the sample of this study. Specific characteristic of the sample is that they are being educated in crowded classrooms. Further, the people living in this district has a low socio-economic level, generally parents did not receive much education and graduated from primary school, even some are illiterate.

Since the researcher is a mathematics teacher at Tayfur Sökmen Elementary School, she conducted this study at this school. Thus, the researcher used convenience sampling which is a group of individuals who are conveniently available for the study. In this school, there were already three 8^{th} grade classrooms and two classrooms were chosen for the study. The control and the experimental groups were randomly selected and assigned among these three classes, that is each class as a whole had chance to be selected as an experimental group or as a control group. All the three classes' classroom sizes and mathematics achievement levels were similar. There were approximately 50 students in all classes. The table below shows the numbers of participants of the study in terms of gender.

Table 3.1 Number of Male and Female Students

Groups	Male	Female	Total
Experimental Group	21	35	56
Control Group	21	35	56

In this part information regarding population and sample are mentioned and in the next part measuring instruments will be stated.

3.3 Instruments

The purpose of the research study is to investigate the effect of peer instruction method and gender on the 8th grade students' mathematics achievement and attitudes towards learning the topic transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms. Thus, Mathematics Achievement Test (MAT) and Attitude towards Mathematics Scale (ATMS) were used in order to gather data for this study. Details of these measuring instruments will be given in the next parts.

3.3.1 Mathematics Achievement Test (MAT)

The Mathematics Achievement Test which was used to measure students' mathematics achievement levels was prepared by the researcher. There were 14 open-ended questions in the test and test items were prepared by considering the objectives given in the curriculum published by Ministry of National Education (2009-2010) related to the topic of transformation geometry. The table of specification related to the objectives is available in the Appendix A and the details of the preparation of the mathematics achievement test is given below.

3.3.1.1 Pilot Study of the Mathematics Achievement Test

A pilot study for MAT was conducted at a school in Küçükçekmece district in Istanbul, which was different from the school where the main study was conducted. Participants of the study were 8th graders. Totally there were 34 participants, 15 of whom were male and 19 of whom were female. Fifty minutes were given students to complete the achievement test. Firstly, there were seventeen questions; however, after examining the pilot study's results, three questions were eliminated from the test since they were not clear for students. In addition, two questions' wording was changed. A sample question which was changed is shown in the *Figure 3.2*.

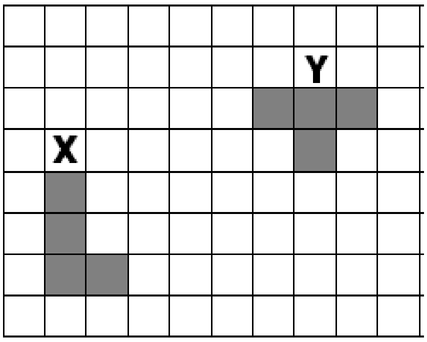
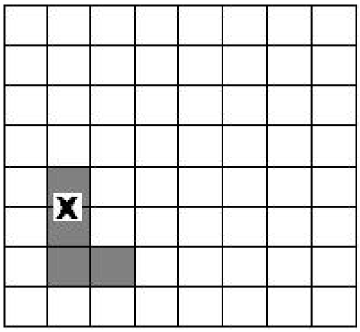
Pilot Study	Main Study
Aşağıdaki şekil birim karelerden oluşmuştur. X cismi yukarı yönde 3 birim, sağa doğru 4 birim öteleniyor. Oluşan şekil nasıl olur aşağıdaki boş kutuya çiziniz ve cevabınızı açıklayınız.	Aşağıdaki şekil birim karelerden oluşmuştur. X cismi yukarı yönde 4 birim, sağa doğru 3 birim ötelenirse şeklin son hali nasıl olur çiziniz ve cevabınızı açıklayınız.
	

Figure 3.2 A sample question which was changed.

In the pilot study, while the students were joining the patterns, since they painted boxes with black pencils, they had difficulties in counting the boxes and although it was an easy question, it caused conflict. While drawing, students translated X but they could not understand what they would do with Y. Therefore we removed Y.

3.3.1.2 Validity and Reliability Issues of the Mathematics Achievement Test

Validity was defined as the adequate and appropriate interpretations of any measurement (Linn & Miller, 2005). As mentioned above according to the objectives of the topics in the curriculum, a specification table was prepared.

In order to check the validity issues of the test, the definition of what was wanted to be measured objectively, the MAT, and the table of specification along with the description of the intended sample were given to an area expert from mathematics education department and to two mathematics teachers who are able to render an intelligent judgment about the adequacy of the instrument. They were asked to look at the content of the instrument and to judge it in order to obtain content-related evidence of validity.

The consistency of scores - how consistent the scores are is called as reliability (Fraenkel & Wallen, 2006). In order to determine the reliability of the MAT, firstly an inter rater value was calculated. Researcher and a mathematics teacher calculated the students' scores separately using the same rubric given in the *Figure 3.3*. During the assessment part each question was rated as 0, 1, 2, or 3 according to the answers. Then scores' correlations were checked. The inter rater coefficient was calculated as .98 for the pilot study and the same coefficient was calculated as .99 for the main study. According to Fraenkel and Wallen (2006) the basic rule is the fact that reliability should be at least .70 and it is generally preferred to be higher. Therefore, it can be said that reliability values of the MAT, both in the pilot and main study, were high and these were the evidences for reliability.

Scores	**Answer Types**
0	• No answer • Completely irrelevant or off-topic answer (e.g. *Fig 3.4*)
1	• Partial understanding without explanation (e.g. in question 6 it was expected from students both to translate and to reflect the shape. If a student was able to translate the shape but was not able to reflect the shape or vice versa and if s/he was not able to explain the result) • Some hints that show the mathematical understanding or mathematical concepts (fractals, rotation, reflection, translation, etc.) familiarity (e.g. similar to the above example, if student was able to translate or rotate or reflect the object correctly even that is not the expected correct result) • Minimal understanding of the task • Misunderstanding of the question and the correct answer through that misunderstanding without explanation (e.g. in question 6, although it was asked students to translate the shape 8 units, a student translated 10 units or it was asked students to translate the shape 8 units, a student translated 10 units or it was asked students to translate the shape down

(Figure 3.3 Continued)

1	but s/he translated the shape up or it was asked students to reflect the shape upon the x axis but s/he reflected the shape upon the y axis correctly without explanation.)
2	• Correct answer without explanation (e.g. in question 1, the answer was correct but there was no explanation.) • Mistake sourced drawing • Correct rule application but wrong result (e.g. in question 5, the definition of fractals was correct but the drawing was incorrect or any other explanation was correct but drawing was incorrect or in question 10, although it was asked to translate 4 units, student translated 3 units but s/he explained the result as it was 4 units, i.e. only drawing was incorrect) • Limited success resulting in an inconsistent or flawed explanation • Correct drawing without explanation (e.g. question 8 and 11, an example is available in Appendix B) • Insufficiency and lacking in some minor ways of answer or explanation (e.g. in question 5, while defining fractals the main difference between fractals and patterns was not explained, i.e. lack of information or explanation)
3	• Correct answer with sufficient explanation (e.g. in question 5 both the definition of fractals and the drawings were correct, and in question 14 the shape's rotation direction and rotation angle were correct) • A response demonstrating full and complete understanding

Figure 3.3 Open-ended questions' scoring rubric.

In the *Figure 3.4*, there is an answer of a student which was scored through this rubric. Also, there are two more samples of answers in the Appendix B.

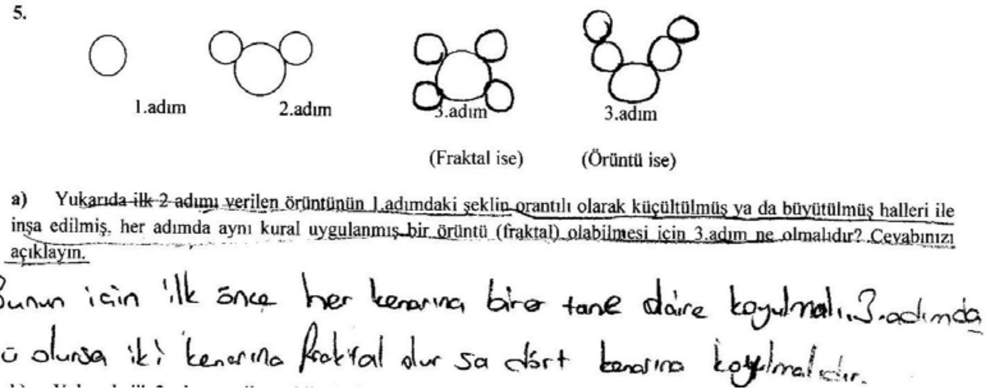


Figure 3.4 A sample question from a student's answer paper.

In this answer student was given 0 point in part "a" because both the drawing and the explanation were incorrect.

Finally, there were 14 items in the MAT and MAT was used both as pretest and posttest. The items of the MAT are available in the Appendix G.

3.3.2 The Attitude towards Mathematics Scale (ATMS)

In order to understand the effect of the peer instruction method on students' attitudes towards mathematics, an attitude scale (ATMS) developed by Askar (1986) was used after the treatment as posttest. The ATMS was used in order to examine the students' own thoughts and feelings such as fear, significance, interest, joy and sympathy related to the mathematics lesson. The ATMS was a five-point Likert-type scale consists of 20 statements about attitudes towards mathematics half of which were negatively worded. There were five options for each item. Participants were expected to choose one of the options which reflect their ideas from the options; (1) strongly disagree, (2) disagree, (3) not sure, (4) agree, and (5) strongly agree.

Possible scores on the ATMS scale range from 0 to 80. For internal consistency, Cronbach's alpha for the ATMS was calculated as .95 which is accepted as high in social sciences (Fraenkel & Wallen, 2006). The ATMS are given in the Appendix C.

In this part instruments are given and in the next part data collection procedure will be explained.

3. 4 Data Collection Procedure

The purpose of the research study is to investigate the effect of peer instruction method and gender on the 8th grade students' mathematics achievement and attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms.

After the pilot study, as mentioned above, referring to the students' answers and their understanding of the questions, the items in the test were eliminated or changed. The following step was to get through to the school where the main study would be conducted.

During the academic year 2009-2010, the time schedule for mathematics lessons was planned and the lesson plans were prepared. There were two classes and each had 56 students which was suitable for this study. At this school before the study started, the purpose of the study and the procedures were explained to the participants. Since the researcher was the instructor in both classes only procedures were explained to the students briefly. After giving the brief information about the study, in the first lesson mathematics achievement test was applied to the participants as pretest. Students were required to complete the test in fifty minutes and after this lesson, implementation of the treatment started. It continued for 10 class hours in 3 weeks. Each lesson period was 40 minutes. After this treatment period, the same mathematics achievement test was applied to the both groups as posttest. There were 6 weeks time between the pretest and posttest. All the students in both groups completed the tests alone. Subsequently, attitude scale was applied in both groups in order to see whether the peer instruction method had any effects on students' attitudes towards mathematics.

3.4.1 Instruction in Experimental and Control Groups

Firstly, different lesson plans were prepared for each group and for each lesson. Examples from lesson plans and the activity papers are given in the Appendix

D, E and F. In the table below, there are the titles of the subjects which were taught to each group on each day during the treatment.

Table 3.2 Time Schedule of the Data Collection in Experimental and Control Groups

Day	Date	Experimental/Control Group	Class Hours
1	10.11.2009	Pretest	2
2	8.12.2009	Fractals	2
3	10.12.2009	Fractals	2
4	15.12.2009	Translation	2
5	17.12.2009	Reflection and Translation	2
6	22.12.2009	Rotation	2
7	29.12.2009	Posttest	2

Instruction for the study lasted for 3 weeks as shown in the table above. In the experimental group, peer instruction was used, which was different from the control group. Except for the peer instruction method, all the procedures, all the activity papers were the same in both groups. In the experimental group, as tutors and tutees the task distribution was arranged by the instructor among the students working in peers and what was required from the students was clearly explained to the students again by the instructor. The experimental group was informed that they would study in groups of three or four, the success or failure of the individuals would be attributed to the whole group, and the responsibility would be shared. The control group was informed about that each student would study on his/her own; they could not ask any questions to their friends except for the teacher. In both classes lessons were carried out on a big screen where students could easily follow. The shapes which were difficult to draw on their notebook were reflected on the board by using overhead projector. Students were directed to thought by directing some questions. Details of the treatment in experimental and control group are given below.

3.4.1.1 Treatment in Experimental Group

In the experimental group peer instruction method was used which was different from the control group as mentioned above. In the experimental group, each student had the chance to ask his/her questions to his/her peers who has the role of tutor instead of the instructor. During the whole treatment in experimental group, students were encouraged to study together and help each other with their peers. With the help of peer instruction method it was expected that the students interact in a constructive manner about tasks and each student was involved in the task.

The teacher only guided the discussions in this classroom. Teacher never gave the correct answer to the students directly; she always tried to make students find the correct answers on their own through asking questions. She tried to control all the groups and did not interrupt when they asked questions. The teacher was passive whereas the students were active. For instance, firstly, in the lesson in which fractals were studied, students were asked what they remembered about patterns from their previous classes. Afterwards, they were given a worksheet which included just patterns in one column and fractals in the other column and the students were asked whether there was a difference between the patterns in the two columns and if there was a difference they were required to write what these differences could be (worksheet is given in Appendix E). In the experimental group, students examined the worksheets with their peers. Afterwards results they had found were discussed altogether in the class. Thus, they could discover what fractal was on their own before the definition was given. Then the definition of fractal was given and the fractal shapes in the nature was shown and examined through the projection. Finally, the students were informed about the history of fractal, and the questions in their coursebooks were given as homework. In the next lesson, another worksheet about fractals was given and students were required to fill the worksheet with their peers (worksheet is available in Appendix F). After waiting for a while for this study, problems were solved on the board by discussing on them. The other lessons continued in this way.

3.4.1.2 Treatment in Control Group

In the control group during the treatment period all the students studied alone. They dealt with the activity papers alone. When students asked something teacher never gave the correct answer to the students directly; she always tried to make students find the correct answers on their own by asking questions as in experimental group. However, instructor was much more active compared to the experimental group because more questions were raised and it was difficult for students to find the correct answer by themselves. For instance, during the lesson in which fractals were studied, the process of the lesson was the same with the experimental group. They were given the same time to study but in the control group they were expected to study individually. In other words, students did not have a chance to ask any friend when they failed; only s/he had chance to ask his/her questions to the instructor. In other words, students always had to wait for the teacher for their questions.

In this part data collection procedure and treatment both in experimental and control groups are explained and in the next part data analysis will be mentioned.

3.5 Data Analysis

In order to analyze the data, quantitative research methodologies were used. In quantitative data analyses, descriptive and inferential statistics were utilized by using SPSS 15 windows program. In descriptive statistics, mean, minimum and maximum scores, standard deviation values of pretest and posttest scores of mathematics achievement test were calculated. Plot graphs, percentages and frequency tables were also used in order to support and describe the data. In inferential statistics, in order to measure the effect of peer instruction method on the 8^{th} grade students' mathematics achievement and gender differences while teaching the subjects of fractals, rotation, reflection and translation, Two-Way Analysis of Covariance (two-way ANCOVA) was used. From the two-way ANCOVA, several interpretations were done. Firstly, it was checked that whether there was a statistical significant difference between the groups' mathematics achievement, in other words whether peer instruction had a significant effect or not. Moreover, it was examined whether there was a gender difference in students' mathematics achievement.

Afterwards, Eta square was calculated in order to see the size of the effect of the study. Effect size simplifies the practical importance of the results (Pallant, 2001).

For the second research question, Two-Way Analysis of Variance (two-way ANOVA) was used in order to see the effect of peer instruction method on the 8^{th} grade students' attitudes while teaching the subjects of fractal, rotation, reflection and translation. Again gender difference was taken into consideration. With the two-way ANOVA, first it was checked that whether there was a statistical significant difference between the groups' mathematics attitude scores, in other words whether peer instruction was significant or not. Afterwards, it was examined whether there was a gender difference in students' attitudes towards mathematics. Then, Eta square was calculated in order to see the practical significance of the study.

In this section data analysis procedure is given and in the next section assumptions and limitations will be given.

3.6 Assumptions and Limitations

Assumptions and limitations are going to be mentioned in this section. First of all, it was assumed that there were no differences among students in terms of age, intelligence, belief, maturity, and socioeconomic background. Also, it was assumed that all the students answered all the questions by thinking and paying attention. Besides, while completing the attitude scale, students were assumed that they answered all the items honestly and chose the choice which they really felt. Further, it was assumed that the researcher did not have prejudgments during the application and interpretation processes.

In this study, school was not selected randomly, and neither were students. Already existing and intact groups were used and this was the main limitation of the study because the generalizability of the study was limited. In addition, the teacher in both classes is also the researcher. This may be regarded as limitation because she knows the purpose of the study. Moreover, this study is restricted to one grade level and specific topic in mathematics. Beside these, attitude scale only used once after the treatment which is also a limitation. It would be better to use attitude scale as pretest before the treatment and as a posttest after the treatment.

3.7 Internal and External Validity of the Study

Both internal validity and external validity threats for this study were discussed in the last part of the methodology chapter.

3.7.1 Internal Validity

Possible threats to the internal validity of this study and the procedures to cope with these threats are discussed in this part. If the noticed differences on the dependent variable are straight forwardly related to independent variable but not some other unintentional variable, it is called internal validity (Fraenkel & Wallen, 2006). The probable internal validity threats alter according to the research design in experiment studies. In this study static-group pretest-posttest design was used. According to Fraenkel and Wallen (2006), the threats such as testing, subject characteristic, mortality, location, data collector bias, data collector characteristics, history, attitude of subjects and implementation, were difficult to control, and these threats were likely to occur. The threats such as maturation, instrument decay, and regression had some ways to control. State differently, the threat might occur in an experimental study. Thus, in the below these threats will be discussed.

The locations in which data are collected may cause location threat and may need extra explanations for results (Fraenkel & Wallen, 2006). In this study, the classrooms were similar to each other and they were next to each other. There were not any difference between the classrooms, even their sizes were similar. The particular locations were constant during the treatment. Therefore, location was not a possible threat for this study.

Data collector characteristics could not be a possible threat for this study because the instructor was the same in both classrooms. In this study, the researcher implemented the treatment and administered the tests. In other words, during the study researcher was the instructor in both classes.

In both classrooms researcher was the instructor as mentioned above and researcher knew the purpose of the study and therefore data collector bias was a possible threat. In other words, the data collector may unconsciously distort the data in order to support the hypothesis (Fraenkel & Wallen, 2006). However, in order to handle this threat, during this study all procedures, such as the time on each task were the same. Researcher, tried to equalize everything including activities. Also, in each class all the questions, which were asked by students, were answered without giving the answer directly. In both classes purpose was to make students discover the solutions. Except for the peer instruction method, all other lesson plans were the same.

Students feel that someone cares about them and tries to help them when they receive special consideration and recognition and this positive effect is called Hawthorne effect (Fraenkel & Wallen, 2006). Experimental group is suggested to perform better due to the novelty of the treatment more than the nature of the treatment. On the other hand, control group may feel demoralized and this could be a threat as their performance is affected. To eliminate these effects, teacher made the peer instruction sessions less novel and part of a regular routine. In this way, students in the control group can not realize what is going on in the other class. Besides, control group was also taught with peer instruction method after the study, comparable to that received by the experimental group in order to handle this effect.

Implementation threat may occur when different people carry out treatments in a different manner and it affects the objectivity of the tests (Fraenkel & Wallen, 2006). However, in this study same researcher carried out treatments so this threat was pretended. Furthermore, if there is a personal bias for one of the treatments to other one, implementation threat may be mentioned. However, in this study all the procedures were the same for both groups except for the peer instruction method in order to prevent this threat.

Lose of subjects in a study refers to the mortality threat (Fraenkel & Wallen, 2006). During the study there was not any dropout, and thus mortality was not a possible threat.

There can be instrumentation problems if the nature of the instrument is changed in anyway. This usually happens when instrument leads to different interpretations of results or when scoring is long or difficult (Fraenkel & Wallen, 2006). In order to control instrument decay, the basic method is scheduling data collection and scoring (Fraenkel & Wallen, 2006). In this study, two teachers read the papers using the same rubric while scoring. Also, as mentioned above data collection procedure was standardized. Therefore this threat was minimized and taken under control.

As two tests carried out in this study, also testing would be a possible threat. That is to say a pretest can make students more aware, sensitive and responsive towards the subsequent treatment (Fraenkel & Wallen, 2006). However, in this study in order to reduce this threat, six weeks period was set between pretest and posttest.

Another important internal validity threat for this study is history. Some unexpected situations during the study may affect participant's responses to the tests (Fraenkel & Wallen, 2006). During this study no unexpected event occurred.

If the selection of people for a study, results of the individuals or groups which are different from each other in unintended ways related to the variables to be studied, it is called subject characteristics threat (Fraenkel & Wallen, 2006). However, at this school students are not divided into classes according to their special characteristics. At the beginning of the 6th grade they were assigned randomly to three classes. This can minimize this threat.

The too long period in the treatment could be a maturation threat because of change such as aging or experience during treatment (Fraenkel & Wallen, 2006). But, since there were six weeks between pretest and posttest in this study, maturation was not a threat.

Lastly, statistical regression threat could occur if the participants were chosen with respect to their previous very high or low scores (Fraenkel & Wallen, 2006). But the classes were assigned randomly as a whole class and therefore this was not a threat in this study.

3.7.2 External Validity

The external validity is the extent how much the result of a study can be generalized (Fraenkel & Wallen, 2006). The extent how sample represents the population of interest is population generalizability (Fraenkel & Wallen, 2006). All the 8th grade students in Istanbul were identified as target population of this study.

The 8^{th} grade students in Kucukcekmece district in Istanbul were the accessible population for this study and the two classes of the 8^{th} grade students in Tayfur Sokmen Elementary School in Kucukcekmece district in Istanbul were the sample of this study. Convenience sampling method was used in order to select the sample of the study as mentioned above. Thus, since the sample was not selected randomly, generalization could not be made. On the other hand, the ecological generalizability is defined as an extension degree of the results to other conditions and settings (Fraenkel & Wallen, 1996). In present study, both the classrooms were sunny and warm with big windows with approximately 50 students and all the treatments and testing procedures took place during regular class time. As a result, present study results can be generalized to the public elementary schools in central Küçükçekmece district of Istanbul and also any other public elementary schools which have similar settings and conditions.

In this chapter design of the study, population and sample, instruments, data collection procedure, data analysis, assumptions, limitations, internal and external validity of the study are explained and in the next chapter results and conclusions will be given.

CHAPTER 4

RESULTS

This chapter aims to offer the results in the sections of descriptive statistics and inferential statistics, in order to examine the effect of peer instruction method on students' mathematics achievement and attitudes towards mathematics.

4.1 Descriptive Statistics

In this section descriptive statistics on pretest and posttest scores of mathematics achievement test and the scores of attitude test are given. The data were collected during the fall semester of the 2009-2010 academic year. Totally, 112 students responded to mathematics achievement test. There were 2 groups, Group 1 was treated as experimental group and Group 2 was treated as control group. Table 1 illustrates descriptive statistics of both groups' pretest and posttest scores of mathematics achievement test.

Table 4.1 Descriptive Statistics of Groups' Pretest and Posttest Scores of Mathematics Achievement Test

Group		Pretest (out of 78)	Posttest (out of 78)
1	N	56	56
(Exp)	Minimum	0.00	14.00
	Maximum	46.00	76.00
	Mean	17.52	55.23
	Std. Deviation	10.49	15.07
2	N	56	56
(Ctrl)	Minimum	1.00	3.00
	Maximum	42.00	64.00
	Mean	17.34	36.82
	Std. Deviation	10.21	14.71
Total	N	112	112
	Minimum	0.00	3.00
	Maximum	46.00	76.00
	Mean	17.43	46.03
	Std. Deviation	10.31	17.47

Table 4.1 is an overall summary of the descriptive statistics gathered from the pretest-posttest scores of mathematics achievement test in experimental and control groups. As shown in the table, experimental group's pretest mean score in mathematics achievement test is 17.52 (*SD* = 10.49) while the posttest mean score is 55.23 (*SD* = 15.07). On the other hand, control group's pretest mean score in the same test is 17.34 (*SD* = 10.21) while the posttest mean score is 36.82 (*SD* = 14.71). As a result, it can be seen that in experimental group, the increase between the students' pretest mean scores and posttest mean scores is 37.71 which constitutes 48.34% while in control group the increase is 19.48 which constitutes 24.97%. In addition, Table 4.2 illustrates the comparison of the female and male students' minimum-maximum scores, mean and standard deviation of the mathematics achievement scores.

Table 4.2 Descriptive Statistics of Female and Male Students' Pretest and Posttest Scores of Mathematics Achievement Test

Gender		Pretest (out of 78)	Posttest (out of 78)
Male	N	42	42
	Minimum	0.00	3.00
	Maximum	42.00	73.00
	Mean	16.48	45.52
	Std. Deviation	10.55	18.57
Female	N	70	70
	Minimum	0.00	11.00
	Maximum	46.00	76.00
	Mean	18.00	46.33
	Std. Deviation	10.19	16.91
Total	N	112	112
	Minimum	0.00	3.00
	Maximum	46.00	76.00
	Mean	17.43	46.03
	Std. Deviation	10.31	17.47

In the table, overall summary of the descriptive statistics gathered from the pretest-posttest scores of mathematics achievement test of female and male students is given. As shown in the table, male students' pretest mean score in mathematics achievement test is 16.48 (*SD* = 10.55) while the posttest mean score is 45.52 (*SD* = 18.57). On the other hand, female students' pretest mean score in the same test is 18.00 (*SD* = 10.18) while the posttest mean score is 46.33 (*SD* = 16.91). As a conclusion, the increase in male students' mean scores from pretest to posttest is 29.04 which constitutes 37.23%, while the increase in female students' mean scores from pretest to posttest is 28.33 which constitutes 36.32%. Moreover, Table 4.3 illustrates descriptive statistics of both groups' mathematics attitude test.

Table 4.3 Descriptive Statistics of Groups' Mathematics Attitude Test Scores

Group		Total Attitude Scores
1	N	56
(Exp)	Mean	80.29
	Std. Deviation	12.02
2	N	56
(Ctrl)	Mean	48.82
	Std. Deviation	17.22
Total	N	112
	Mean	64.55
	Std. Deviation	21.64

In the table, overall summary of the descriptive statistics gathered from the total scores of mathematics attitude test in experimental and control group is given. As shown in the table, experimental group's mean score in mathematics attitude test is 80.29 (*SD* = 12.02) while the control group's mean score in the same test is 48.82 (*SD* = 17.22). As a result, it can be seen that in experimental group, mean value of total attitude scores is higher than the mean scores in control group. In addition, Table 4.4 illustrates the comparison of the female and male students' mean and standard deviation value of the mathematics attitude scores.

Table 4.4 Descriptive Statistics of Female and Male Students' Mathematics Attitude Test Scores

Gender		Total Attitude Scores
Female	N	70
	Mean	63.57
	Std. Deviation	22.79
Male	N	42
	Mean	66.19
	Std. Deviation	19.72
Total	N	112
	Mean	64.55
	Std. Deviation	21.64

Table 4.4 is an overall summary of the descriptive statistics gathered from the both female and male students' scores of mathematics attitude test. As shown in the table, female students' mean score in mathematics attitude test is 63.57 (SD = 22.79) while the male students' mean score in the same test is 66.19 (SD = 19.72). As a result, it can be seen that male students' mathematics attitude scores are higher than female students' scores.

In this section, descriptive statistics on mathematics achievement test and attitude test were mentioned. In the next section inferential statistics will be given.

4.2 Inferential Statistics

The purpose of the research study was to investigate the effect of peer instruction method on the 8th grade students' mathematics achievement and mathematics attitudes on transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students). The second purpose of the study was to investigate the gender differences regarding mathematics achievement and mathematics attitude.

In the following sections results of the research hypothesis are given.

4.2.1 The Effect of Peer Instruction Method and Gender on the 8th Grade Students' Mathematics Achievement

To investigate the effect of peer instruction method on the 8th grade students' mathematics achievement on transformation geometry and to investigate the gender differences regarding mathematics achievement test, Two-Way Analysis of Covariance (Two-Way ANCOVA) was conducted. There is a significant relationship between the dependent variable and the covariate while controlling the independent variables (Pallant, 2007). The pretest was treated as covariate to control pre-existing differences between the experimental group and the control group. The significance value of pretest is .000 which means that the covariate was significant. In this study, besides the covariate, there were two categorical independent variables with two levels (group: experimental/control; gender: female/male), and one continuous dependent variable (posttest).

4.2.1.1 Assumptions of Two-way ANCOVA for Achievement

Before conducting two-way ANCOVA, assumptions which were discussed in Pallant (2007), were checked. Those were level of measurement, independence of observations, normality, homogeneity of variance, influence of treatment on covariate measurement, homogeneity of regression slopes and linearity.

4.2.1.1.1 Level of Measurement

Pallant (2007) states that, the assumption of each parametric approach is that the dependent variable is measured at the interval or ratio level; using a continuous scale instead of discrete categories. In this study the dependent variable was posttest scores of mathematics achievement test and it was a continuous variable.

4.2.1.1.2 Independence of Observations

The observations of the study must be independent from one another, that is to say none of the observation or measurement should be influenced by any other (Pallant, 2007). Stevens (1996) stated that the violation of this assumption was very serious. In this study it was assumed that the measurement did not influence each other.

4.2.1.1.3 Normality

Populations from which the samples are taken are assumed to be normally distributed for parametric techniques (Pallant, 2007). The violation of this assumption ought not to cause any major problems with large enough sample sizes (e.g. 30+) (Pallant, 2007). In this study, both the sample sizes were bigger than 30 and scores were normally distributed. In order to check this assumption, skewness and kurtosis values of the test can be considered. These values are given in the table below.

Table 4.5 Skewness and Kurtosis Values of Pretest and Posttest of Mathematics Achievement Test

	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
Pretest	10.31	.379	.228	-.169	.453
Posttest	17.47	-.268	.228	-.817	.453

Since the skewness and kurtosis values are between -2 and 2 (Pallant, 2007) as seen in the table, the normality of both scores is supported. Further, the figures below also show the distribution.

Also, the two histograms below with normal curves support the normality of pretest and posttest scores of mathematics achievement test.

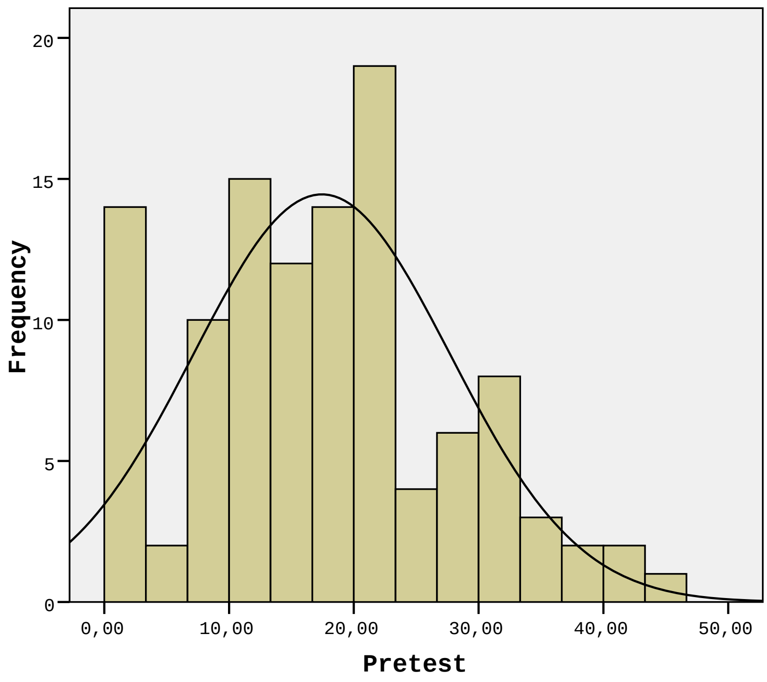


Figure 4.1 Histogram of pretest scores of mathematics achievement test.

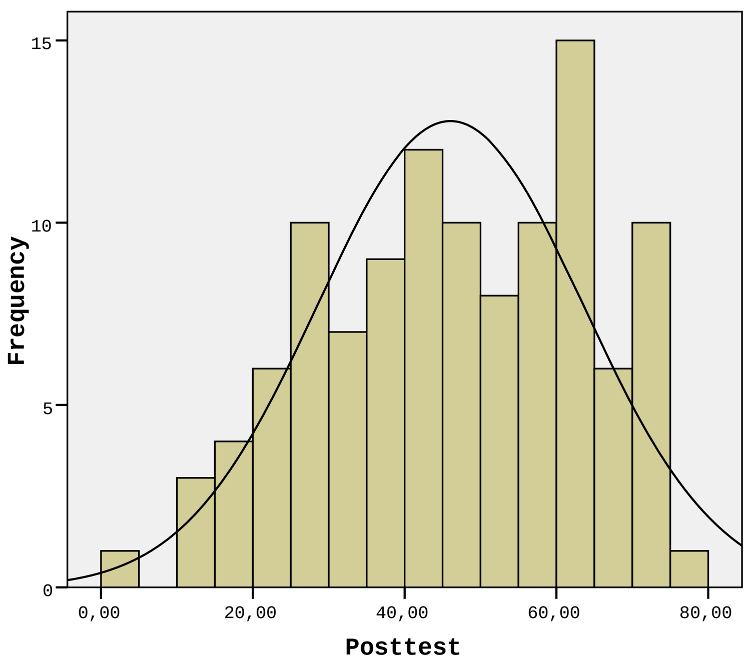


Figure 4.2 Histogram of posttest scores of mathematics achievement test.

4.2.1.1.4 Homogeneity of Variance

According to parametric techniques, it is assumed that samples are obtained from populations of equal variances. Therefore, the variability of each groups' scores is similar (Pallant, 2007). In this analysis, Levene's Test of Equality of Error Variances showed that homogeneity of variance assumption has not been violated ($p = .688$).

4.2.1.1.5 Influence of Treatment on Covariate Measurement

The covariate was measured before the treatment started, so that the pretest scores' being influenced by the treatment was avoided. This means that this assumption has not been violated.

4.2.1.1.6 Homogeneity of Regression Slopes

This assumption means the interaction between the covariate and the dependent variable for each of the groups (Pallant, 2007). In here the interaction of group and pretest ($F(1, 106) = .277$, $p = .600$) and the interaction of gender and pretest are not significant ($F(1, 106) = .660$, $p = .418$). In other words, there is no interaction between the covariate and the treatment. Therefore, it can be said that assumption of homogeneity of regression slopes has not been violated.

4.2.1.1.7 Linearity

Linearity means the linear relationship between the dependent variable and the covariate for all groups (Pallant, 2007). In order to check this, it is sufficient to consider the figures below.

As shown in the *Figure 4.3* and *4.4*, the relationship is clearly linear for both groups and gender, so the assumption has not been violated.

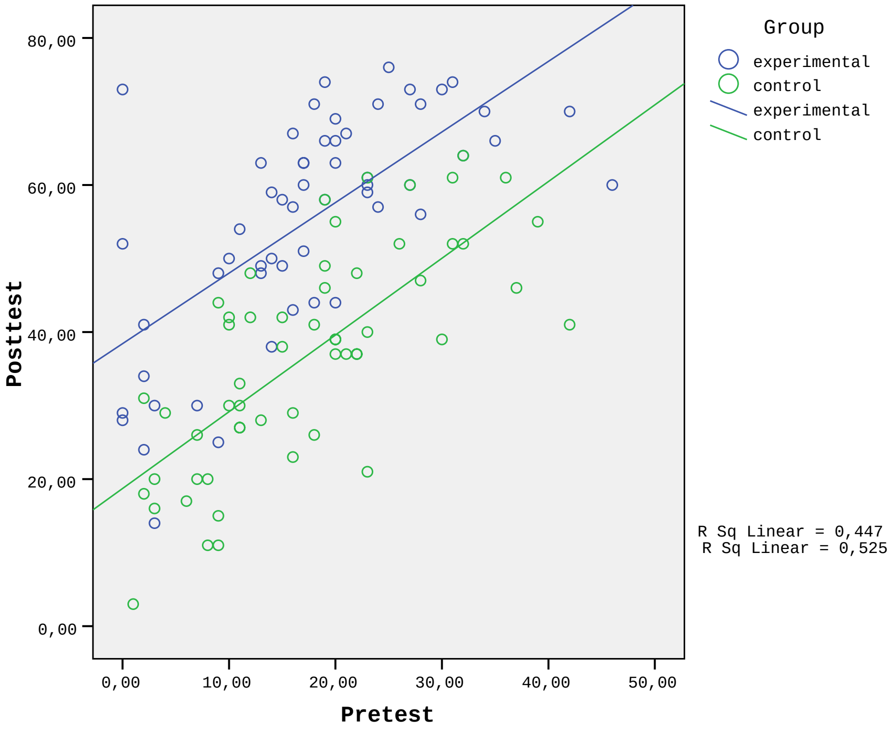


Figure 4.3 Scatterplot of scores with respect to the groups

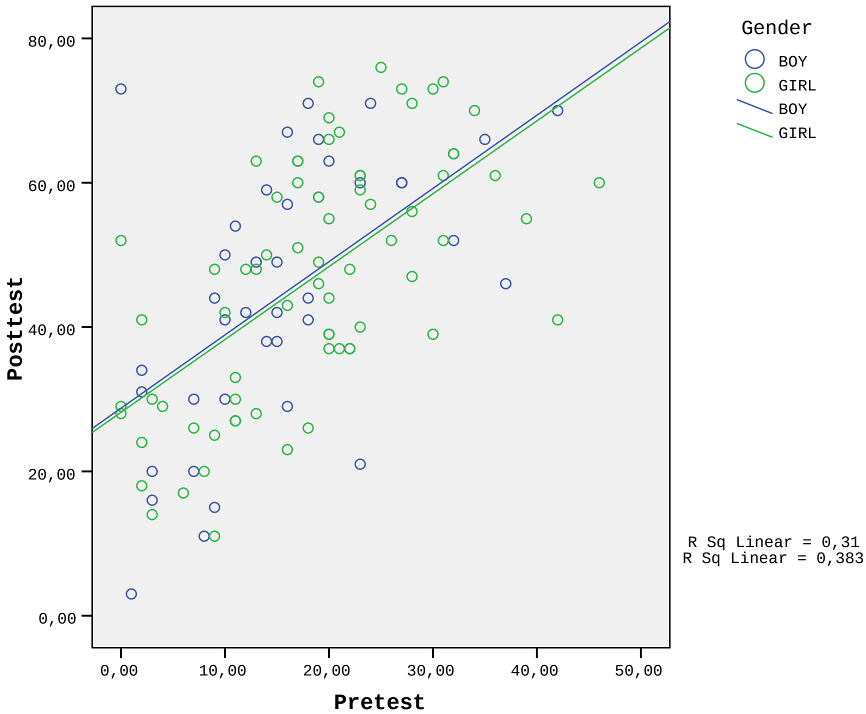


Figure 4.4 Scatterplot of scores with respect to the gender.

4.2.1.2 Investigation of the Research Problems

After checking the assumptions, two-way ANCOVA analysis could be proceeded in order to investigate the effect of peer instruction method and gender on the 8th grade students' mathematics achievement in transformation geometry. The inferential statistics of the test are given in the Table below.

Table 4.6 Inferential Results on Mathematics Achievement Test

Source	df	F	Sig.	Eta Squared
Corrected Model	4	45. 89	.00	.63
Pretest	1	99.93	.00	.48
Group	1	78.69	.00	.42
Gender	1	.11	.73	.00
Group*Gender	1	.79	.38	.01
Error	107			
Total	112			

In the table, overall summary of the inferential statistics for mathematics achievement test is given. As shown in the table, there was not a significant interaction effect. F (1, 107) = .79, p= .38; with a small effect size (partial eta squared= .01). The main effect for group was statistically significant while the main effect for gender was not statistically significant. Group: F (1, 107) = 78.69, p= .00; with a large effect size (partial eta squared= .42); gender: F (1, 107) = .11, p= .73; with a small effect size (partial eta squared= .00). This means that the difference between male and female students' mathematics achievement scores was not significant but there was a significant difference between the experimental and the control groups' achievement scores where experimental group's scores were higher than the control group's scores. Also, this result indicates that males and females did not differ in terms of their mathematics achievement scores but there was a difference in scores of the experimental group and the control group. In other words, these results show that 42% of the mathematics achievement can be explained by the group. In the figure below, the relationship among group, gender, and mathematics achievement score is given.

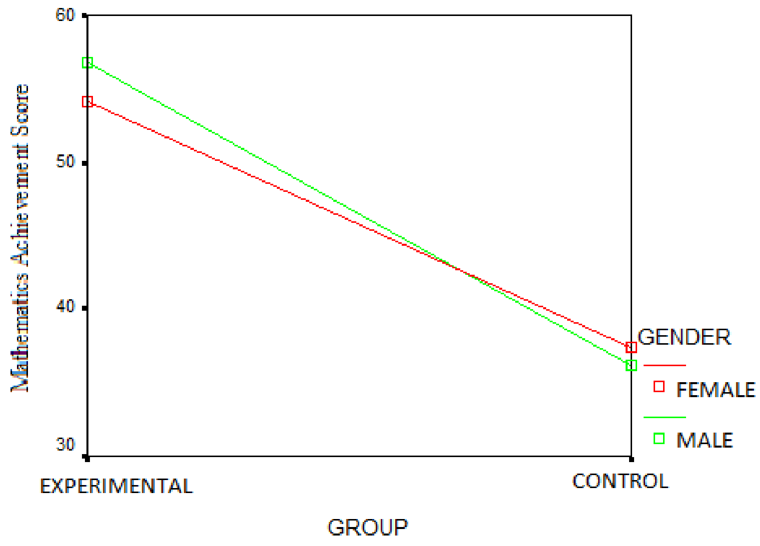


Figure 4.5 The relationship among group, gender, and mathematics achievement score.

As shown in the *Figure 4.5*, in experimental group, male students' posttest scores are higher than female students' scores while in control group female students' posttest scores are higher than male students' scores.

In this section the inferential statistics of mathematics achievement test were stated and in the following section the inferential statistics of attitude towards mathematics scale will be mentioned.

4.2.2 The Effect of Peer Instruction Method and Gender on the 8th Grade Students' Mathematics Attitude

To investigate the effect of peer instruction method and gender on the 8th grade students' mathematics attitude in transformation geometry, Two-Way Analysis of Variance (two-way ANOVA) was conducted. In this analysis, there are two categorical independent variables with two levels (group: experimental/control; gender: female/male), and one continuous dependent variable (the scores of attitude towards mathematics scale).

4.2.2.1 Assumptions of Two-Way ANOVA for Attitude

Before conducting two-way ANOVA, assumptions which were discussed in Pallant (2007), were checked. Those were level of measurement, independence of observations, normality, and homogeneity of variance.

4.2.2.1.1 Level of Measurement

As mentioned above, in this study since the dependent variable (total attitude score) is continuous; this assumption has not been violated.

4.2.2.1.2 Independence of Observations

In this study, as mentioned above, it is assumed that the observations of the data are independent from one another, in other words they do not influence each other.

4.2.2.1.3 Normality

In this study, firstly the total attitude scores were calculated and the normality of the scores was tested. In this study, as mentioned above both the sample sizes were bigger than 30 and scores were normally distributed. The distribution of scores and the skewness and kurtosis values for each of the groups are shown in the table below.

Table 4.7 Skewness and Kurtosis Values of Attitude Scores

	N	Std. Deviation	Skewness		Kurtosis	
		Statistic	Statistic	Std. Error	Statistic	Std. Error
Attotal	112	21.639	-.196	.228	-1.094	.453

Since the skewness and kurtosis values are between -2 and 2 as seen in the table, it can be said that the total attitude scores were distributed normally (Pallant, 2007). Also, the figure below supports the normality of the total attitude scores.

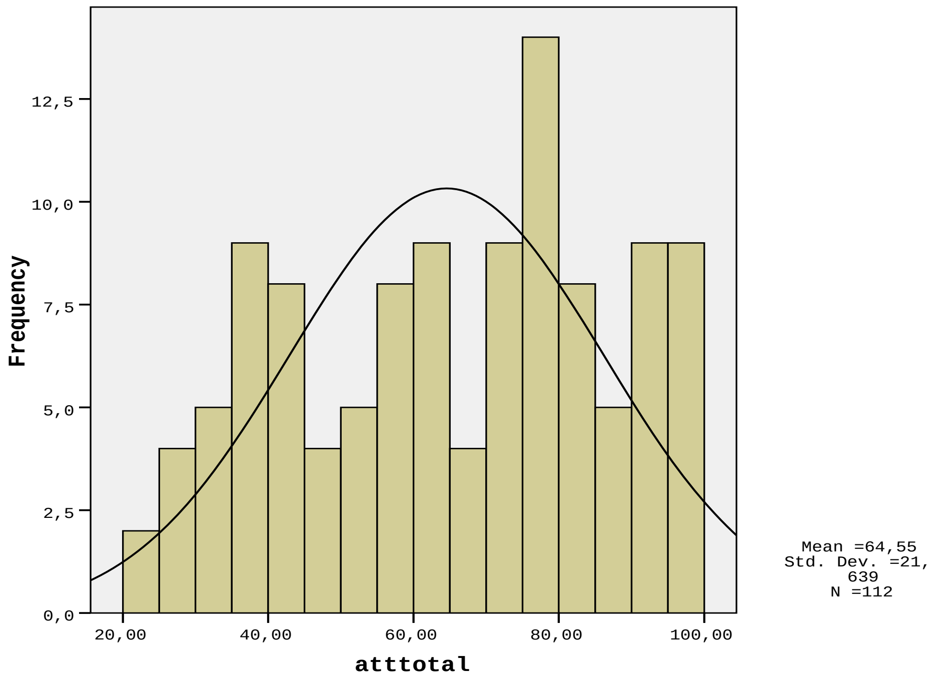


Figure 4.6 Histogram of attitude scores of mathematics attitude test.

The histogram above with normal curves also supports the normality of the total attitude scores of mathematics attitude scale.

4.2.2.1.4 Homogeneity of Variance

As mentioned above, according to parametric techniques, it is assumed that samples are obtained from populations of equal variances (Pallant, 2007). In this analysis, Levene's Test of Equality of Error Variances showed that homogeneity of variance assumption has been violated ($p = .013$). As it can be seen, the result is significant which means the variance of the dependent variable across the groups is not equal (Pallant, 2007). In this case, it is recommended in Pallant (2007) that setting is a more stringent significant level (e.g. .01) for evaluating the results, in other words interaction effect is significant only if the significance value is greater than .01.

4.2.2.2 Investigation of the Research Problems

For the purpose which was mentioned above, two-way ANOVA was conducted. The inferential statistics of the test are given in the Table below.

Table 4.8 Inferential Results on Attitude Towards Mathematics Scale Scores

Source	df	F	Sig.	Eta Squared
Corrected Model	3	45.53	.00	.56
Intercept	1	2091.12	.00	.95
Gender	1	1.97	.16	.02
Group	1	111.25	.00	.51
Gender*Group	1	4.18	.04	.04
Error	108			
Total	112			

In the Table 4.8, overall summary of the inferential statistics of the research problems is given. As shown in the table, the interaction effect between sex and group was statistically significant, F (1, 108) = 4.18, p= .04; with a small effect size (partial eta squared= .04). This means that 4% of the total attitude can be explained by the group and gender interaction. The main effect for group was statistically significant while the main effect for gender was not statistically significant. Group: F (1, 108) = 111.25, p= .00; with a large effect size (partial eta squared= .51); gender: F (1, 108) = 1.97, p= .16; with a small effect size (partial eta squared= .02). This indicates that being in an experimental and control group explains 51% of the variance in attitude toward mathematics.

The significant interaction effect suggests that females and males respond differently to ATMS in the experimental and control groups. Also, the results showed that similar to achievement scores, the difference between male and female students' mathematics attitude scores was not significant but there was a significant difference between the experimental and the control groups' attitude scores. In other words, experimental groups' scores were higher than the control groups' scores. In the figure below, the relationship among group, gender, and mathematics attitude score is given.

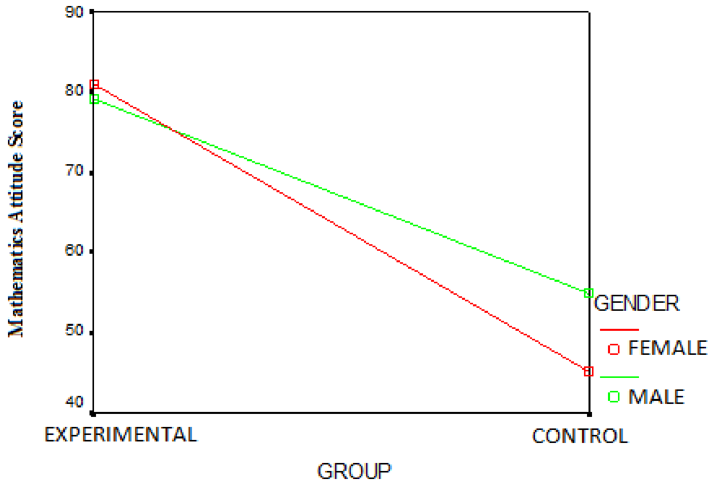


Figure 4.7 The relationship among group, gender, and mathematics attitude score.

As shown in the *Figure 4.7*, in experimental group, female students' attitude scores were higher than male students' scores while in control group male students' attitude scores were higher than female students' scores and this interaction was significant.

In this chapter descriptive statistics and the inferential statistics of the study was explained and in the next chapter discussions, implications and recommendations will be given.

CHAPTER 5

DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The purpose of this research study is to investigate the effect of peer instruction method on the 8th grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students). Moreover, in this study it is aimed to investigate the gender differences regarding mathematics achievement and mathematics attitudes.

This chapter consists of the discussion of the findings of the study regarding to the previous studies, with implications and recommendations for the future research studies.

5.1 Discussion of the Findings on Students' Mathematics Achievement

Firstly, the results of the two-way ANCOVA have revealed that there is a statistically significant effect of peer instruction method on students' mathematics achievement test scores. In other words, students who were applied peer instruction method got significantly higher scores on MAT than the students who were not applied. This study results are consistent with many studies in the literature. In those studies it was shown that several group working methods (peer instruction method, peer learning method, cooperative learning, etc.) positively affected students' mathematics achievement (Brown, 1993; Burke & Sass, 2006; Fantuzzo, King, & Heller, 1992; Freemyer, Ajamian & Lecuyer, 1995; Linboe, 1998; Phillips et. al., 1993; Slavin, 1980; Swing & Peterson, 1982; Webb, 1991; Yardım, 2009). Also, many of research studies showed that several group working methods as mentioned above have positive effects on students' achievement related to other lessons such as physics, foreign language courses and social sciences (Allen & Feldman, 1973;

Mynard & Almarzouqi, 2006; Robinson, Schofield & Wentzell, 2005; Tokgöz, 2007).

Peer teaching method has been used by educators for centuries to spread information to the large number of students (Lindboe, 1998) and positive effects of peer instruction have been explained by many researchers. One of the reasons of this result might be that with the help of this method each child has the opportunity of being included in the task actively (Hooker, 2010). To state differently, many research studies in the literature have emphasized the importance and the necessity of students' active involvement in the task (Brown & Campione, 1986). Also, with the constructivist perspective, students' interaction with the material and his/her friends are undeniable facts for effective instruction (as cited in Leikin & Zaslavsky, 1997). Thus, active involvement of students in present study might have increased students' mathematics achievement.

Different from these, as mentioned in the literature part, students may understand each other's misunderstandings or faults better and they may teach the concepts to their peers by using simple terms that their peers can understand since they are at the same age or at the same level (Hooker, 2010; O'Donnell, 2006; O'Donnell & O'Kelly, 1994). Besides, students in groups, comprehend different perspectives, variable problem solving methods and different ways of mathematics (Fraboni & Moller, 2008; Jones, 1993). This might be another reason for this result. In other words, while students are studying on transformation geometry, with the help of their communication and interaction, their achievement may increase. This was supported by Johnson and Johnson (1999) as mentioned before, students achieve better while working with their peers than working individually.

Lastly, students are able to take quick feedback from their peers during the treatment which might cause better understanding. To state differently, students do not have to wait for the teacher or wait for his/her turn to ask questions or to get feedback. Moreover, while students are teaching to another student, s/ he practices the topic and feels himself compulsory to do preparation before, to explain the topic better (Rittschof & Griffin, 2001). These might be other reasons for that students who were applied peer instruction method got higher grades.

On the other hand, this present study's results are inconsistent with some other research studies in the literature. For instance, Connelly (2010) found no change on students' academic achievement after implementation of peer tutoring. Also, according to the results of the study which Swing and Peterson (1982) conducted with the task related interaction, achievement of high and low ability students improved while the achievement of medium ability students did not. Moreover, in another study reciprocal peer tutoring (RPT) treatment was applied to students and results indicated that RPT did not improve the understanding of students when compared to individual study (as cited in Rittschof & Griffin, 2001).

The reason of these different results may be that they were conducted on different topics and different levels from the present study. For instance, Swing and Peterson (1982) conducted their study on 5th grade students. Also, Rittschof and Griffin (2001) conducted their study on undergraduates and graduates. These participants' grade levels are different from the present study's participants' grade levels. Thus, peer instruction method might affect the 8th grade students' mathematics achievement whereas it has not got any effect on the 5th grade students or graduates and undergraduates.

5.2 Discussion of Gender Differences Regarding Mathematics Achievement

Secondly, the results of two-way ANCOVA have revealed that there is not a significant gender difference between 8th grade students' mathematics achievement test scores. When we consider the gender difference regarding mathematics achievement, it can be seen that the gender difference has been examined in several studies. In the literature there are a few similar results which support the present study's results (Boulter, 1992; Capraro, 2000; Lawton, Charleston, & Zieles, 1996; Linn & Petersen, 1985; Vale & Leder, 2004). For instance, Pleet (1990) conducted his study on the 8th grade students on transformation geometry topic. He examined the effect of different computer programs on transformation geometry where he could not find a significant difference between males and females while measuring spatial visualization and mental rotation ability. Further, Capraro (2000) conducted a study on 6th grade students and reported no significant difference between male and female students' geometric spatial visualization. Besides, Fennema and Sherman (1978) investigated the relationship among mathematics learning, verbal ability, spatial visualization and eight effective variables. They posed that there were not a significant sex-related differences in middle school areas.

The literature offered some possible reasons for this result. For instance, Capraro (2000, p.116) explained the reasons for this result as: "Males were no more likely to play with blocks or assemble or disassemble their toys than females. Males and females often spoke of the same board games they played such as Monopoly, Scrabble, Backgammon and Chess".

As mentioned above, the games that are played by males and females are the same since their early childhood. State differently, their childhood experiences are not different anymore. Females do not prefer stuffed animals or dolls, or males do not prefer vehicles or blocks which might enhance their spatial abilities as they did before. That is to say their spatial abilities which depend on their mathematical skills do not improve in a different way. Therefore, their mathematics achievement may not differ anymore. Similarly, in this study, it is possible that female and male students' mathematical skills have improved similarly. Thus, their mathematics achievement does not differ at this level.

On the other hand, some of the other studies in the literature indicated that female students regress than male students in geometry (Fennema and Carpenter, 1981; Glennon & Callahan, 1968; Higgins, 2006; Maccoby & Jacklin, 1974; Poltrock & Agnoli, 1986). Possible reason for gender difference in mathematics achievement might be genetic. The left hemisphere of the brain is claimed to work for analytical and logical thinking in verbal and numerical operations and the right hemisphere is claimed to work for spatial tasks and artistic efforts in the literature (Capraro, 2001). Thus, it can be said that males are more advantageous than females if they use spatial strategies. In this present study no gender difference has been found. There might be difference but because of their grade level this difference might not be obvious and it may come out in later years.

Secondly, gender difference in mathematic achievement might occur due to the cultural effects. Female students may not be supported in respect of learning mathematics and may be exposed to prejudge like females cannot manage mathematics. And all these may demotivate female students and their achievement may regress in parallel with this. However, as mentioned above in this present study, gender difference has not been found, may be because there is no cultural difference standing out so much among the students. In other words, it can be said that, since they come from similar background, gender difference has not occurred.

5.3 Discussion of the Findings on Students' Attitudes towards Mathematics

The other aim of this study is to investigate the effect of peer instruction on students' attitudes towards mathematics. The results of two-way ANOVA have revealed that there is a statistically significant effect of peer instruction method on students' attitudes towards mathematics scale scores. In other words, students who were applied peer instruction method got significantly higher scores on attitude towards mathematics scale than the students who were not applied. The literature offered some consistent results with this present study (Brown 1993; Burke & Sass, 2006; Freemyer et. al., 1995; Hooker, 2010; Linboe, 1998; Slavin, 1980; Swing, Peterson, 1982; Topping, Campbell, Douglas & Smith, 2003).

One of the reasons of this result could be the class size. When the classroom is crowded, interaction increases and this might affect students' motivation or attitudes positively. Further, in the literature, many studies have showed that attitude towards mathematics is correlated positively with mathematics achievement (Iben, 1991; Ma & Kishor, 1997; Tartre & Fennema, 1995). For example, Ma and Kishor (1997) analyzed 113 survey studies about the relationship between the mathematics attitude and the mathematics achievement. The findings of the study indicated that positive attitude towards mathematics brings success. In present study, because of the positive attitude towards mathematics might enhance the achievement or as mentioned above the higher achievement scores might influence students' attitudes in experimental group yielding higher scores.

Besides, in the literature it was said that working with small groups changed students' attitudes towards mathematics, such group working methods, as mentioned above, improved student-student and student-teacher interaction, friendship, and also students feel more responsible (Connelly, 2010; Hooker, 2010; Freemyer, Ajamian & Lecuyer; 1995; Mynard & Almarzouqi, 2006). Thus, in this study since peer instruction method might have enhanced students' attitudes positively, students in experimental group got higher scores compared to the control group. Also, students in the experimental group learn how to disagree in a constructive way, ask questions and respond, encourage, praise, show respect, help one another, explain the processes and listen, provide immediate corrective feedback which are compulsory for our lives as well as for a successful group work, and these might be positive factors to increase those students' attitudes toward mathematics (Nath & Ross, 2001).

On the other hand, this present study's results are inconsistent with some other research studies in the literature. In the studies which were conducted by Tokgöz (2007) and Yardım (2009) no significant difference was detected between the attitudes of students who were applied peer instruction method and who were not applied. Furthermore, the study which was reported by Mallinson (as cited in Topping and Bamford, 1998) revealed that same-age peer tutoring project using mathematical games did not constitute a significant attitude difference towards mathematics. In these studies, the classes were not as crowded as in this present study. Crowded classrooms in the present study might cause the difference. In other words, generally direct teaching takes place in crowded classes. Thus, as mentioned above peer instruction method might be an alternative teaching method which positively affects students' motivation and attitudes towards mathematics. Also, these studies were conducted with different grade levels from the present study's grade level. There might be difference on students' attitudes towards mathematics in middle school years but the difference may be diminished as they grow up. Thus, the difference of participants' grade levels might cause different results.

5.4 Discussion of Gender Differences Regarding Mathematics Attitude

In addition to those findings, the results of two-way ANOVA have revealed that there is not a significant gender difference between 8th grade students' attitudes towards mathematics. Similarly, in the study which was conducted by Goh and Fraser (1995) they could not find a difference between male and female students' attitudes towards mathematics. As mentioned above, because of the reasons such as similar childhood experiences, similar job expectations, being supported as much as male students, there occurred no gender difference between male and female students' mathematics achievement. Thus, it is expected that there is no difference between male and female students' attitudes towards mathematics. Namely, this result is in line with the result of male and female students' mathematics achievement test. It can be said that the results of mathematics achievement test may affect the results of attitude towards mathematics scale. Further, in this grade level female and male students might have the same opportunities in the classroom environment. In other words, female students can also express themselves in the classroom atmosphere and take part actively in the lessons as much as male students. The communication among the students and the learning environment might affect females' and males' attitudes in the same way and this might be the reason why there is no gender difference.

Besides, Fennema (1974) asserted that during early elementary years there are no significant differences between boys' and girls' mathematics achievement. Also, during upper elementary and early high school years significant differences were not always obvious.

Another possible reason might be the school district. In this study, the district where the data was collected is not a socially and culturally developed region. If the female students are not successful enough they cannot go on their education after elementary school. That is to say, their parents do not let them go to the secondary school. Thus, female students might be more motivated and this might reduce the gender difference.

In the literature several studies are inconsistent with the present study's result. In many studies, it was shown that male students have more positive attitudes towards mathematics than female students (Betz & Hackett, 1983; Frost et al., 1994; Leder, 1995; Schofield, 1982). For instance, in Betz and Hackett's (1983) study, the participants are college students. Students' grade levels are different from the present study which might cause gender difference on mathematics attitude. Thus, as in the present study, there may not be a difference at this level but there may be at further levels.

In the following part, implications for teacher educators, policy makers, curriculum developers and teachers based on the findings of this research study are given.

5.5 Implications

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

Firstly, mathematics teachers should be aware of different teaching methodologies which are applicable to the mathematics lessons and they should pay special attention to the student centered instruction methods which are easy to implement and do not require too much time and money in order to provide conceptual understanding. Mathematics teachers, especially teachers in crowded classrooms, should emphasize on the teaching methods based on the collaboration among students and peer instruction. Generally, in crowded classrooms direct teaching takes place but this present study indicated that peer instruction is effective in crowded classrooms. To state differently, peer instruction might be an alternative method in crowded classrooms as well as other methods because peer instruction results in positive outcomes for students in crowded classrooms.

Further, faculties of education could take the findings of this study into the consideration while training teachers. During the courses, these alternative teaching methodologies such as cooperative learning, peer instruction method, peer learning method, cooperative learning, collaborative learning and their implementation should be taken into consideration. In other words, the usage of these methods should be encouraged. Especially their usage in crowded classrooms and their advantages should be mentioned. For instance; although many people hear something about the teaching methods, they do not know their treatment and benefits in detail. Therefore these should be discussed.

Also, curriculum developers, textbook authors and researchers could consider present study while preparing guide books for teachers. In the curriculum, five lesson hours are devoted for this topic. In this present study treatment has lasted in 10 lesson hours. Due to the increased instruction time, students' achievement scores might have increased in this study. In other words, the topics are newly added into the curriculum and the number of lessons devoted for these topics are important. Thus, this topic's objectives and lesson hours might be raised. Further, extra time could be devoted for the application of peer instruction method.

In addition to these, Ministery of National Education could take the findings of this study into the consideration. The detailed information related to the peer instruction method and the effective application of it, especially in crowded classrooms, might be included in the curriculum.

In the following part recommendations for further research studies are offered.

5.6 Recommendations for Further Research Studies

In this present study, the main purpose is to investigate the effect of peer instruction method on the 8th grade students' mathematics achievement and mathematics attitudes in transformation geometry (fractals, rotation, reflection, translation) in crowded classrooms (more than 50 students). Moreover, in this study it is aimed to investigate the gender differences regarding mathematics achievement and mathematics attitude. In this part, some recommendations are suggested for further studies in the view of the findings.

Experimental study, the static-group pretest-posttest design was used in this study (Fraenkel & Wallen, 2006). This means that in this study two already existing, or intact groups were used, one of them was experimental group and the other one was control group (Fraenkel & Wallen, 2006). Participants may be assigned randomly to the groups in further research studies so subject characteristic bias would not be a threat anymore. Parallel to this, a convenient sampling method was conducted which limits the generalizability. Further research studies may be conducted in state or private school which is selected randomly. With the help of this, researchers may also have a chance to generalize the findings of the study to the broader circumstances having similar characteristics.

Besides, the sample was consisted of 8^{th} grade students. Thus, a study might be implemented at different grades and the impact of peer instruction method on different grades may be investigated. Moreover, this study was delimitated to transformation topic and further research studies may examine the effect of the peer instruction on students' mathematics achievement and attitudes on different topics of mathematics like trigonometry, probability, 3D objects.

Apart from these, further longitudinal research studies could be conducted in order to examine the effect of peer instruction on students' mathematics achievements and attitudes. That is to say, the effect of peer instruction method can be investigated with the same students at the 6^{th}, 7^{th}, and 8^{th} grades. By this way, the impact of peer instruction method on long-term retention may be investigated and peer instruction method may be checked for whether it provides permanent learning or not.

This study is quantitative in nature. Thus, in order to get deep understanding of why peer instruction method affects students' achievement positively, qualitative research methodologies could be conducted.

5.7 Last Words

I started to use peer instruction method in my classes before my research study. Thanks to this method I have a chance to know the students and realize their inadequacy. By regular classroom instructions, it is impossible to have a chance to communicate with each student in crowded classrooms. However, by the help of this method the students who are assigned as tutors watch their peers closely, realize their misconceptions and inform me about them. In this way I have chance to watch each student and focus on their lacks. For instance, by the help this method we found out that one of our 8^{th} grade students did not understand the concepts of odd and even numbers and I helped him to clarify the topic. With regular classroom instruction I would not realize and think the possibility of this inadequacy. In short, dividing the students into the groups, making them to discuss about the problems together as a group and making them more active in the classroom helped me to control the classroom easily since the class is crowded.

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APPENDICES

APPENDIX A
TABLE OF SPECIFICATION

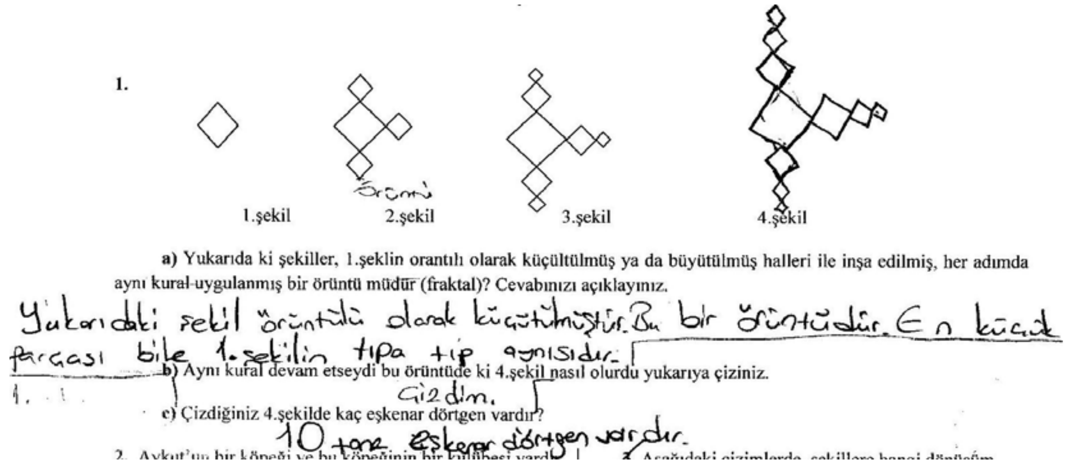
Questions	Objectives						Cognitive Level Steps			
	1	**2**	**3**	**4**	**5**	**6**	**Comprehend**	**Application**	**Analysis**	**Synthesis**
1	x					x	x	x	x	
2			x	x				x		x
3		x	x	x			x		x	
4		x	x		x				x	
5	x							x	x	
6		x	x					x		x
7				x			x			
8				x			x	x	x	
9		x	x	x	x				x	
10		x						x		
11				x				x		
12			x				x			
13	x								x	
14				x			x			

Objective 1: Students should be able to construct and draw patterns with line, polygon and circle models and decide which patterns are fractals.
Objective 2: Students should be able to translate a polygon through a coordinate axis or a line and to draw its image after translation.
Objective 3: Students should be able to draw a polygon's image after making a reflection through a coordinate axis and translation through any line.

Objective 4: Students should be able to explain rotation motion, draw shapes after rotation on a plane and according to the given angle, and draw the image of a polygon under the rotation motion around the origin on a coordinate axis.
Objective 5: Students should be able to determine the image of shapes after making translation with reflection and construct it.
Objective 6: Students should be able to construct patterns and decide the number of shapes in the patterns.

APPENDIX B

SAMPLE OF STUDENT ANSWERS


1.

1.şekil 2.şekil 3.şekil 4.şekil

a) Yukarıda ki şekiller, 1.şeklin orantılı olarak küçültülmüş ya da büyütülmüş halleri ile inşa edilmiş, her adımda aynı kural uygulanmış bir örüntü müdür (fraktal)? Cevabınızı açıklayınız.

Yukarıdaki şekil örüntülü olarak küçültülmüştür. Bu bir örüntüdür. En küçük parçası bile 1. şekilin tıpa tıp aynısıdır.

b) Aynı kural devam etseydi bu örüntüde ki 4.şekil nasıl olurdu yukarıya çiziniz.

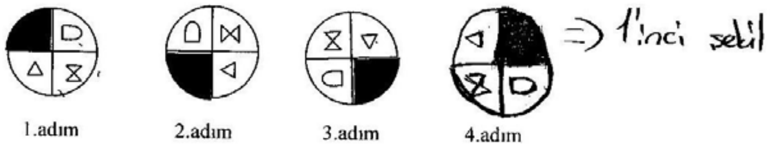
Çizdim.

c) Çizdiğiniz 4.şekilde kaç eşkenar dörtgen vardır?

10 tane eşkenar dörtgen vardır.

In this answer student is given 0 point in part “a” because the explanation is incorrect, her definition belongs to fractals and this pattern is not a fractal. In part “b”, student is given 3 points because the drawing is correct. In part “c”, student is given 3 points because the answer is correct.

8. Aşağıdaki şekiller belli bir kurala göre dizilmiştir. Bu kuralı bulunuz ve 4.adımı bu kuralı göz önünde bulundurarak çiziniz. Cevabınızı açıklayınız.



In this answer, student is given 2 points because although the drawing is correct, there is not explanation.

APPENDIX C

ATTITUDE TOWARDS MATHEMATICS SCALE

Matematik Tutum Ölçeği					
	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
	(1)	(2)	(3)	(4)	(5)
1) Matematik sevdiğim bir derstir.					
2) Matematik dersine girerken büyük sıkıntı duyarım.					
3) Matematik dersi olmasa öğrencilik hayatı daha zevkli olur.					
4) Arkadaşlarımla matematik tartışmaktan zevk alırım.					
5) Matematiğe ayrılan ders saatlerinin fazla olmasını dilerim.					
6) Matematik dersi çalışırken canım sıkılır.					
7) Matematik dersi benim için angaryadır.					
8) Matematikten hoşlanırım.					
9) Matematik dersinde zaman geçmez.					
10) Matematik dersi sınavından çekinirim.					
11) Matematik benim için ilgi çekicidir.					
12) Matematik bütün dersler içinde en korktuğum derstir.					
13) Yıllarca matematik okusam bıkmam.					
14) Diğer derslere göre matematiği daha çok severek çalışırım.					
15) Matematik beni huzursuz eder.					
16) Matematik beni ürkütür.					
17) Matematik dersi eğlenceli bir derstir.					
18) Matematik dersinde neşe duyarım.					
19) Derslerin içinde en sevimsizi matematiktir.					
20) Çalışma zamanımın çoğunu matematiğe ayırmak isterim.					

APPENDIX D

SAMPLE LESSON PLANS OF EXPERIMENTAL GROUP

GEOMETRİK ŞEKİLLERLE ÖRÜNTÜ VE SÜSLEMELER YAPALIM

Öğrenme Alanı: Geometri

Alt öğrenme alanı: Örüntü ve Süslemeler

Kazanım 1: Doğru, çokgen ve çember modellerinden örüntüler inşa eder, çizer ve bu örüntülerden fraktal olanları belirler.

Kavramlar: Örüntü, fraktal

Araç ve Gereç: İzometrik kağıt, bilgisayar, internet, tepe göz, renkli kalem, cetvel, çalışma kağıtları

Yöntem ve Teknikler: Resim ve nesneleri yorumlama, gösterim, tartışma, eşli öğrenme.

Süre: 4 ders saati(40 dk+ 40 dk+ 40 dk+ 40 dk)

Süre: 14dk	• Öğrencilerin araştırdıkları kavramları kendi aralarında tartışmaları (bir önceki derste örüntü ve fraktal kelimelerini araştırmaları istenmiştir.) • Her bir grubun sözcülerinin vardıkları sonuçları teknik terim kullanmadan kendi cümleleri ile açıklamaları(eşli öğrenme yöntemini uygulayabilmek için öğrenciler bir önceki derste eşleştirilmişlerdir.)
Süre: 5 dk	• Örüntü ve fraktal örneklerini içeren kağıdın (Appendix E) dağıtılması • Öğrencilerden bu kağıdı incelemelerinin ve grup halinde tartışmalarının istenmesi (hangileri fraktal hangileri örüntü olabilir)
Süre: 18dk	• Belge 1 ile beraber sınıf içerisinde yapılan çıkarımların tartışılması • Ekte bulunan "sözel bilgi" nin tepegözle açılıp öğrencilerle beraber tartışılması. • Cevapların keşfettirilmesi • Öğrencilerin defterlerine tanım yazdırılması
Süre: 3dk	• Ekte bulunan slayt 1 in öğrencilerle beraber izlenmesi • Slaytta bulunan örneklerde var olan fraktal şekillerinin öğrencilerle birlikte yorumlanması
Süre: 37 dk	• Ekte bulunan slayt 2 nin izlenmesi ve gruplarla beraber tartışılması, çözülmesi ve not alınması
Süre: 3 dk	• Konunun özetlenmesi • Günlük hayatla ve diğer disiplinler ile ilişkilendirilmesi • Neler anladıklarının ve öğrendiklerinin sorulması • Öğrencilere çalışma kitaplarından ödev verilmesi (ders kitabı sayfa 3 sıra sizde etkinliği, çalışma kitabı sayfa 2)

Süre: 2 dk	• Derse giriş • Bir önceki derste öğrenilenlerin hatırlatılması
Süre: 15 dk	• Verilen ödevlerde öğrencilerin yapamadıkları soruların tartışılması, cevapların karşılaştırılması
Süre: 4 dk	• Ekte bulunan çalışma kağıdı 1 in dağıtılması • 1.sorunun eşlerle birlikte tartışılıp çözülmesinin istenmesi
Süre: 2 dk	• Her grubun cevaplarının sınıf içerisinde tartışılması
Süre: 4dk	• 2.sorunun grup halinde tartışılıp çözülmesinin istenmesi
Süre: 4dk	• Her grubun sözcüsünün cevaplarının sınıf içinde tartışılması
Süre: 5dk	• 3.soruyu grup halinde tartışıp çözmelerinin istenme
Süre: 4 dk	• Her grubun cevaplarının sınıf içerisinde tartışılması
Süre: 5 dk	• 4.soruyu grup halinde tartışıp çözmelerinin istenmesi
Süre: 3dk	• Her grubun cevaplarının sınıf içerisinde tartışılması
Süre: 6 dk	• 5.soruyu grup halinde tartışıp çözmelerinin istenmesi
Süre: 3 dk	• Her grubun cevaplarının sınıf içerisinde tartışılması
Süre: 5 dk	• 6.soruyu grup halinde tartışıp çözmelerinin istenmesi
Süre: 3 dk	• Her grubun cevaplarının sınıf içerisinde tartışılması
Süre: 5 dk	• 7.soruyu grup halinde tartışıp çözmelerinin istenmesi
Süre: 4 dk	• Her grubun cevaplarının sınıf içinde tartışılması
Süre: 4 dk	• Konunun özetlenmesi ve bitirilmesi • Günlük hayatla ve diğer disiplinler ile ilişkilendirme
Süre: 2 dk	• Bir sonraki ders ile ilgili bilgi verme ve araştırma yapmalarının istenmesi

GEOMETRİK HAREKETLER YAPALIM

Öğrenme Alanı: Geometri

Alt öğrenme alanı: Dönüşüm Geometrisi

Kazanım 2: Koordinat düzlemi üzerinde bulunan bir çokgenin eksenlerden biri boyunca ya da herhangi bir doğru boyunca öteleme yapıldıktan sonraki görüntülerini belirleyerek çizer.

Kavramlar: Öteleme hareketi

Araç ve Gereç: Kareli kağıt, bilgisayar, internet, tepe göz, renkli kalem, cetvel, çalışma kağıtları

Yöntem ve Teknikler: Resim ve nesneleri yorumlama, gösterim, tartışma, grup çalışması.

Süre: 2 ders saati(40 dk+ 40 dk)

Süre: 10 dk	• Öğrencilerin araştırdıkları öteleme kavramını kendi aralarında tartışmalarının istenmesi • Her bir grubun sözcülerinin vardıkları sonuçları teknik terim kullanmadan kendi cümleleri ile açıklamaları
Süre: 8dk	• Öğrencilerden grup halinde tartışarak ve verilen bilgilerden faydalanarak, ellerinin altında bulunan herhangi bir şeyi ötelemelerinin istenmesi
	• Sözel bilgi 2 nin verilmesi • Öğrencileri tartışma ortamına sürüklenmesi • Öğrencilere defterlerine not almaları için süre verilmesi
Süre: 10 dk	• Çalışma kağıdı 2 nin dağıtılması • Öğrencilerin grup halinde soruların üzerinde tartışmalarının ve soruları çözmelerinin istenmesi
Süre: 6 dk	• Her grubun çalışmalarını izleyip tahta da tartışma yöntemiyle soruların cevaplandırılması ve tahtada çizilmesi
Süre: 5dk	• Tahtaya koordinat düzlemi çizerek bilgilerini tazelemek • Tahtada bir örnek ile koordinat düzlemi üzerinde ötelemenin anlatılması
Süre: 6 dk	• Çalışma kağıdı 3 ün dağıtılması • Öğrencilerin grup halinde soruların üzerinde tartışmalarını ve soruları çözmelerinin istenmesi
Süre: 6 dk	• Her grubun çalışmalarını izleyip tahta da tartışma yöntemiyle soruları cevaplandırılması ve tahtada çizilmesi
Süre: 6 dk	• Çalışma kağıdı 4 ün dağıtılması • Öğrencilerin grup halinde soruların üzerinde tartışmalarını ve soruları çözmelerini isteme

Süre: 6 dk	• Her grubun çalışmalarını izleyip tahta da tartışma yöntemiyle soruları cevaplandırılması ve tahtada çizilmesi
Süre: 6 dk	• Çalışma kağıdı 5 in dağıtılması • Öğrencilerin grup halinde soruların üzerinde tartışmalarını ve soruları çözmelerinin istenmesi
Süre: 6 dk	• Her grubun çalışmalarını izleyip tahta da tartışma yöntemiyle soruların cevaplandırılması ve tahtada çizilmesi
Süre: 3 dk	• Konunun özetlenmesi ve dersin bitirilmesi • Günlük hayatla ve diğer disiplinler ile ilişkilendirme • Ödev verme 1) Çalışma kitabı sayfa 3,2., 3., 5. Sorular 2) Herhangi bir geometrik şekle öteleme hareketini uygulayarak bir süsleme yapma

GEOMETRİK HAREKETLER YAPALIM

Öğrenme Alanı: Geometri

Alt öğrenme alanı: Dönüşüm Geometrisi

Kazanım 3: Koordinat düzlemi üzerinde bulunan bir çokgenin eksenlerden birine göre yansıma hareketi ve herhangi bir doğru boyunca öteleme hareketi yaptıktan sonraki görüntülerini belirleyerek çizer.

Kavramlar: Yansıma ve öteleme hareketi

Araç ve Gereç: Kareli kağıt, bilgisayar, internet, tepe göz, renkli kalem, cetvel, çalışma kağıtları

Yöntem ve Teknikler: Resim ve nesneleri yorumlama, gösterim, tartışma, eşli öğrenme.

Süre: 2 ders saati(40 dk+ 40 dk)

Süre: 5dk	• Öğrencilerden grup halinde tartışarak simetri ve yansıma kavramlarını teknik terim kullanmadan kendi cümleleri ile açıklamaları
Süre: 18 dk	• Slayt 3 ün izlenmesi • Öğrencilere her slaytta söz hakkı verip yorum yapmalarının istenmesi • Öğrencilerin defterlerine not alması
Süre: 7 dk	• Çalışma kağıdı 6 nın dağıtılması • Grupların sorular üzerinde tartışmaları ve çözmeleri

Süre: 9 dk	• Çalışma kağıdı 7 nin dağıtılması • Grupların sorular üzerinde tartışmaları ve çözmeleri
Süre: 9 dk	• Çalışma kağıdı 8 in dağıtılması • Grupların sorular üzerinde tartışmaları ve çözmeleri
Süre: 3 dk	• Sozel bilginin verilmesi 3(ekte)
Süre: 13dk	• Çalışma kağıdı 9 un dağıtılması • Grupların sorular üzerinde tartışmaları ve çözmeleri
Süre: 13 dk	• Çalışma kağıdı 10 un dağıtılması • Grupların sorular üzerinde tartışmaları ve çözmeleri
Süre: 3 dk	• Dersin özetlenmesi ve konunun bitirilmesi • Günlük hayatla ve diğer disiplinler ile ilişkilendirme • Ödev verme a) Ders kitabı sayfa 7 sıra sizde etkinliği 1. Soru, sayfa 9 sıra sizde etkinliği soru 1 ve 2 b) Çalışma kitabı sayfa 3, 1. Ve 4. Sorular, sayfa 4 soru 5, sayfa 5 hepsi

GEOMETRİK HAREKETLER YAPALIM

Öğrenme Alanı: Geometri

Alt öğrenme alanı: Dönüşüm Geometrisi

Kazanım 4: Koordinat düzlemi üzerinde bulunan bir çokgenin orijin etrafındaki dönme hareketi altındaki görüntülerini belirleyerek çizer.

Kavramlar: Dönme hareketi

Araç ve Gereç: Kareli kağıt, bilgisayar, internet, tepe göz, renkli kalem, cetvel, çalışma kağıtları

Yöntem ve Teknikler: Resim ve nesneleri yorumlama, gösterim, tartışma, grup çalışması.

Süre: 2 ders saati(40 dk+ 40 dk)

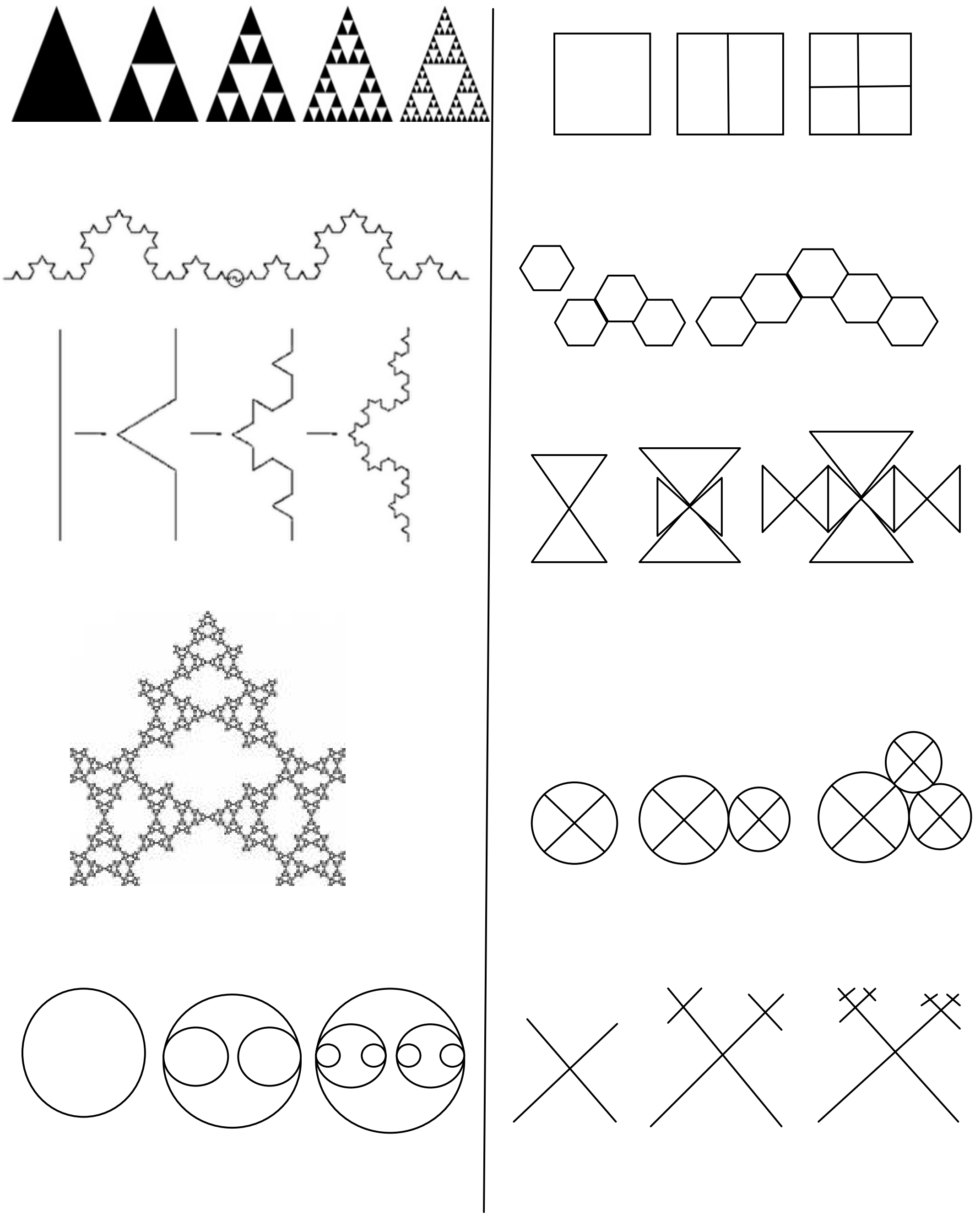
Süre: 5 dk	• Öğrencilerin ön öğrenmelerinin ortaya çıkarılması • Tartışma ortamının yaratılması
Süre: 35 dk	• Slayt 4 ün tartışarak izlenmesi • Öğrencilerin not alması

Süre: 20 dk	• Çalışma kağıdı 11 in dağıtılması • Öğrencilerin grup halinde tartışmaları ve çözmeleri
Süre: 15 dk	• Sınıf içinde cevapların tartışılması ve sonuca ulaştırılması
Süre: 5 dk	• Konunun özetlenmesi • Günlük hayatla ve diğer disiplinler ile ilişkilendirme • Ödev verilmesi a) Ders kitabı sayfa 7 sıra sizde etkinliği soru 2 ve 3, sayfa 10 Alıştırmalar b) Çalışma kitabı sayfa 3 soru 6,7,8 ve 9

APPENDIX E

SAMPLE WORKSHEET

GRUP 1 **GRUP 2**

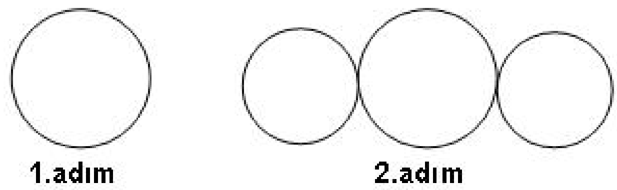


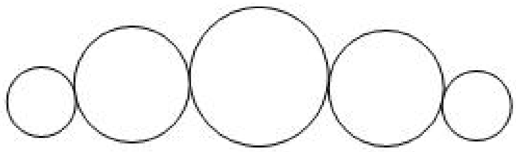
Yönerge: Yukarıdaki şekil gruplarını inceleyiniz ve aradaki farkları grubunuzla tartışınız.

APPENDIX F

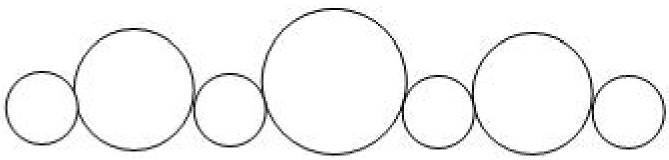
SAMPLE WORKSHEET

1)





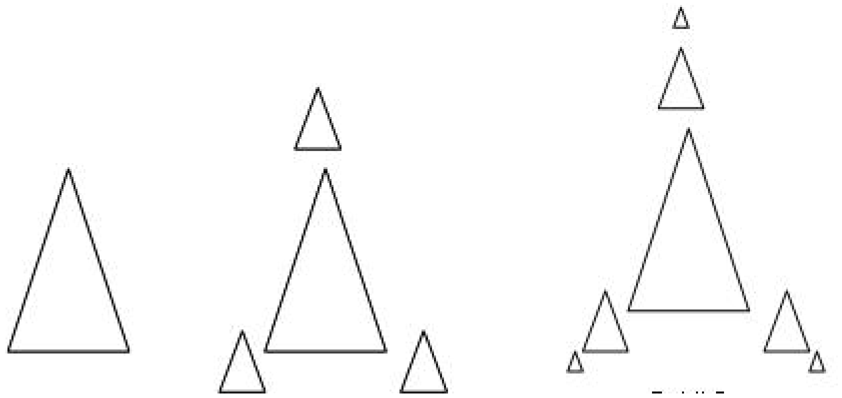
ŞEKİL A



ŞEKİL B

a) Yukarıda 1. ve 2. adımı verilen şeklin devamında hangi şekil (ŞEKİL A, ŞEKİL B) gelirse fraktal olur? Sebepleriyle açıklayınız.
b) 3. adımda "şekil A" gelirse 4. adım nasıl olur çiziniz.
c) 3. adımda "şekil B" gelirse 4. adım nasıl olur çiziniz.

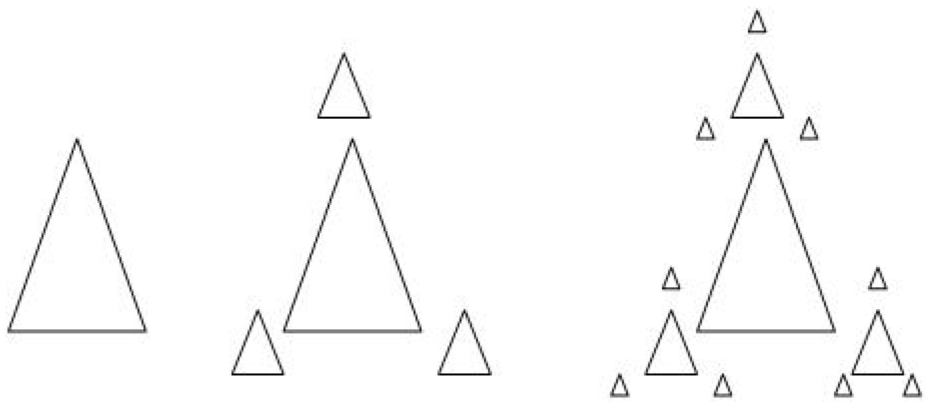
2)



1.adım 2.adım 3.adım

a) Yukarıda ilk 3 adımı verilen şekil bir fraktal mıdır? Neden?
b) Bu örüntünün 4.adımını çiziniz.
c) Bu örüntünün 4. adımında kaç üçgen bulunur?

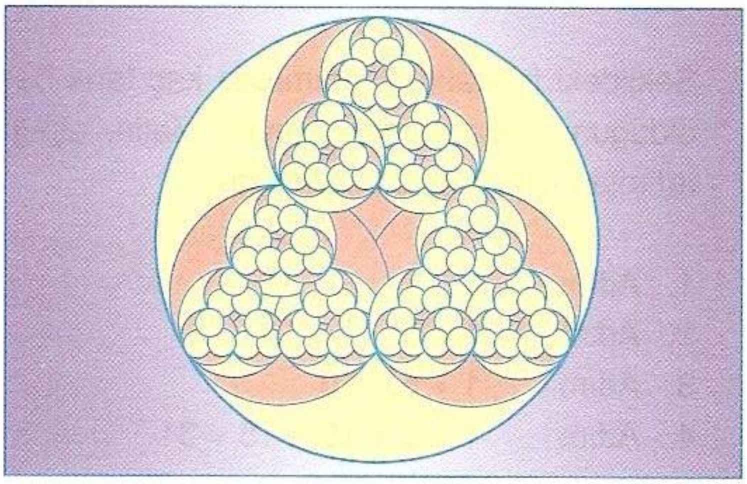
3)



1.adım 2.adım 3.adım

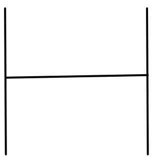
a) Yukarıdaki ilk 3 adımı verilen şekil bir fraktal mıdır? Neden?
b) Bu örüntünün 4.adımını çiziniz.
c) Bu örüntünün 4.adımında kaç üçgen bulunur?

4)

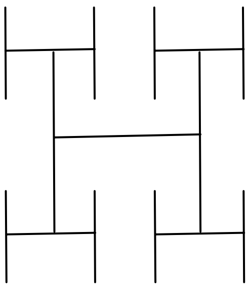


Bir fraktalın kaçıncı adımında yukarıdaki şekil meydana gelir?

5)



1.adım



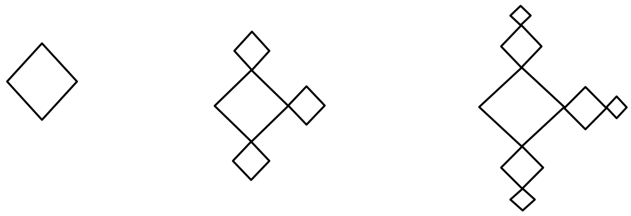
2.adım

a)Yukarıda 1. ve 2.adımları verilen örüntünün fraktal olabilmesi için 3.adım ne olmalıdır? Çiziniz.
b) 3.adımdaki “H” harfi sayısını hesaplayınız.

APPENDIX G

MATHEMATICS ACHIEVEMENT TEST
MATEMATİK BAŞARI TESTİ

1.



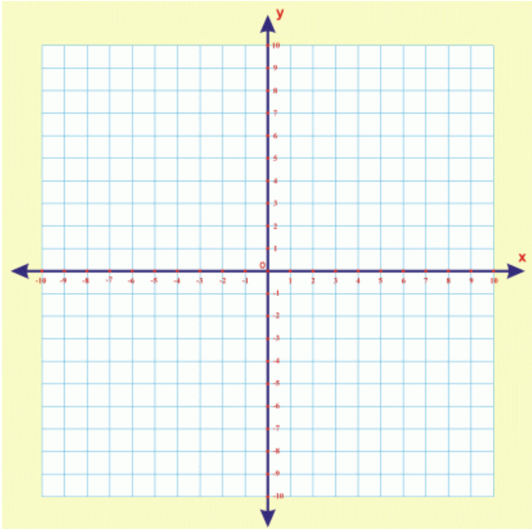
1.şekil 2.şekil 3.şekil 4.şekil

a) Yukarıda ki şekiller, 1.şeklin orantılı olarak küçültülmüş ya da büyütülmüş halleri ile inşa edilmiş, her adımda aynı kural uygulanmış bir örüntü müdür (fraktal)? Cevabınızı açıklayınız.

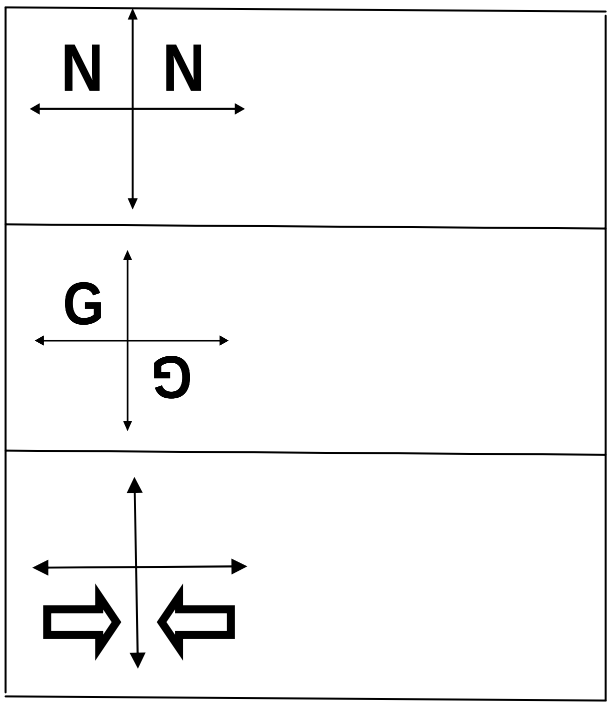
b) Aynı kural devam etseydi bu örüntüde ki 4.şekil nasıl olurdu yukarıya çiziniz.
c) Çizdiğiniz 4.şekilde kaç eşkenar dörtgen vardır?

2. Aykut'un bir köpeği ve bu köpeğinin bir kulübesi vardır.
a)Bu kulübenin yerini beğenmeyen Aykut, kulübeyi evin etrafında saat yönünde 90°döndürmek istiyor. Aşağıdaki koordinat düzlemi üzerine köşelerinin koordinatları K(3, -3), L(6, -3), M(3,-8) ve N(6,-8) olarak belirlenen kulübeyi ve de dönme hareketi sonrasındaki yerini çiziniz. <u>**(evi orijin noktası olarak kabul ediniz)**</u>

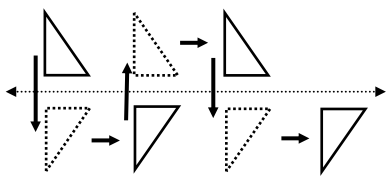
b) Dönme hareketi sonrasında oluşan yeni kulübenin şeklini y ekseni üzerinde yansıtınız ve oluşan şeklin koordinatlarını şeklin köşelerine yazınız.



3. Aşağıdaki çizimlerde, şekillere hangi dönüşüm hareketlerinin yaptırıldığını belirleyip şeklin yanına yazınız.



4. Yandaki şekilde yapılmış olan dönüşüm hareketlerini sırasıyla aşağıdaki noktalı yere yazınız.



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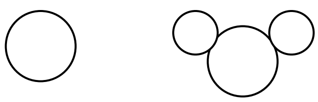
5.

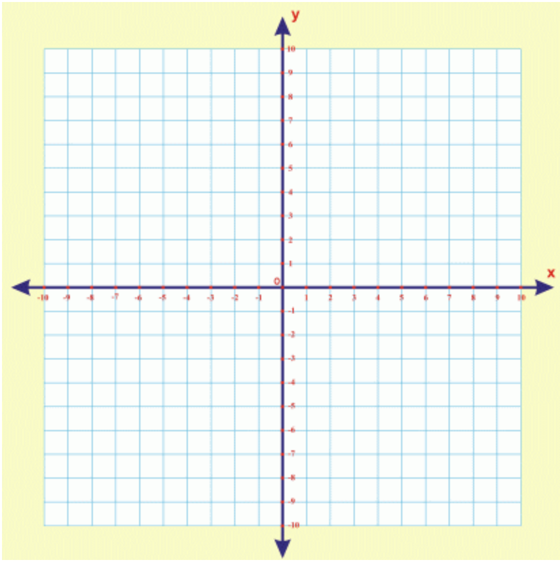


1.adım 2.adım 3.adım (Fraktal ise) 3.adım (Örüntü ise)

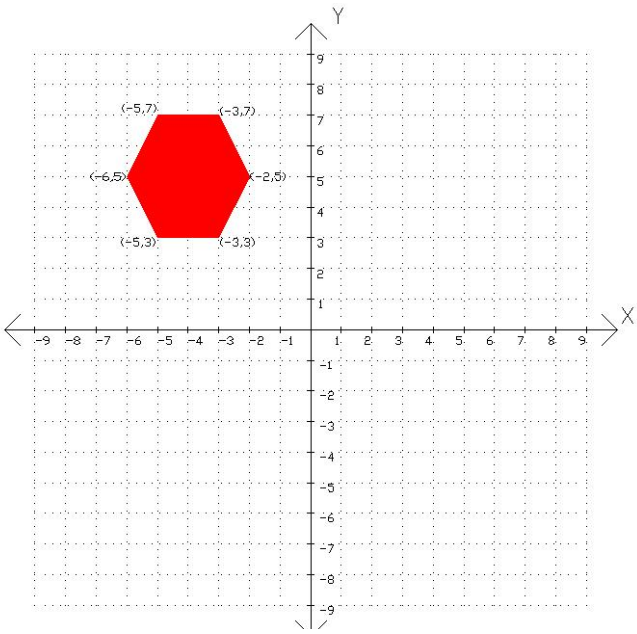
a) Yukarıda ilk 2 adımı verilen örüntünün 1.adımdaki şeklin orantılı olarak küçültülmüş ya da büyütülmüş halleri ile inşa edilmiş, her adımda aynı kural uygulanmış bir örüntü (fraktal) olabilmesi için 3.adım ne olmalıdır? Cevabınızı açıklayın.

b) Yukarıda ilk 2 adımı verilen şeklin 3.adımını siz belirleyiniz ve fraktal olmayan bir örüntü oluşturunuz. Cevabınızı açıklayın.

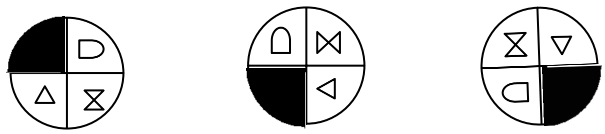
6. Aşağıdaki koordinat düzlemi Ali'nin evinin banyosunun yukarıdan görüntüsüdür. Banyoda var olan bir kelebeğin bacaklarının koordinatları A(1,2), B(6,2), C(6,6) ve D(1,6) şeklindedir. Bu kelebek koordinat düzlemine göre 8birim aşağıya yürürse aynadaki bacaklarının görüntüsünün koordinatları nasıl olur eksen üzerinde gösteriniz. **(aynayı x ekseni olarak düşününüz)**



7. Koordinatları A(-5,7), B(-3,7), C(-2,5), D(-3,3), E(-5,3) ve F(-6,5) şeklinde verilen bir uçurtma, rüzgârın etkisiyle koordinat düzlemi üzerindeki orijin etrafında saat yönünde 270° lik bir dönme hareketi yapıyor. Uçurtmanın koordinat düzlemi üzerindeki yeni görüntüsünü çiziniz ve koordinatlarını şeklin üzerine yazınız.



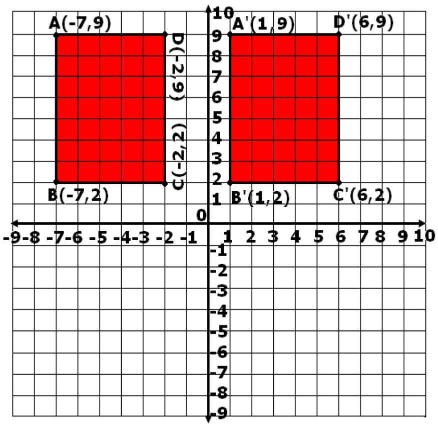
8. Aşağıdaki şekiller belli bir kurala göre dizilmiştir. Bu kuralı bulunuz ve 4.adımı bu kuralı göz önünde bulundurarak çiziniz. Cevabınızı açıklayınız.



1.adım **2.adım** **3.adım** **4.adım**

9. Aşağıdaki grafiklerde yapılmış olan dönüşüm hareketlerini koordinat eksenlerinin altına yazınız.

a)



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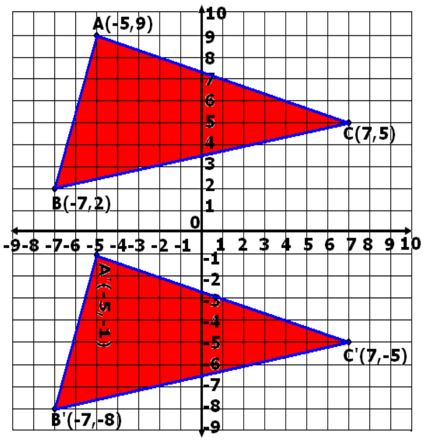
b)



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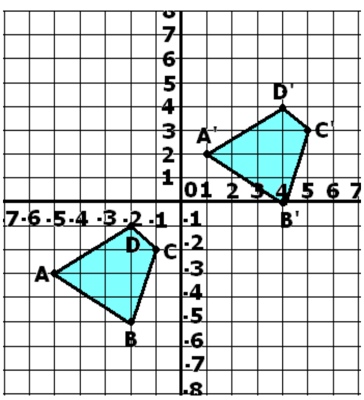
c)



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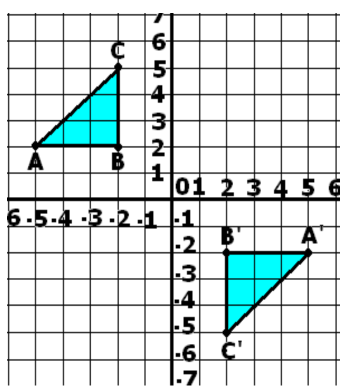
d)



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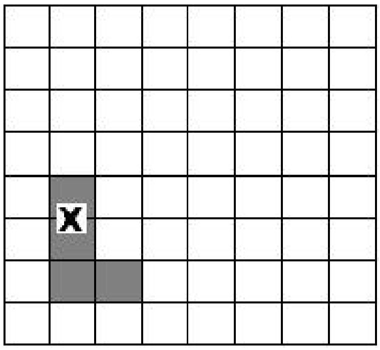
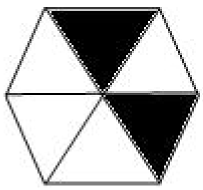
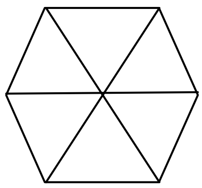
10. Aşağıdaki şekil birim karelerden oluşmuştur. X cismi yukarı yönde 4 birim, sağa doğru 3 birim ötelenirse şeklin son hali nasıl olur çiziniz ve cevabınızı açıklayınız.



11. Aşağıda <u>içi taralı olarak verilmiş altıgenin</u> (1. şekil), saatin tersi yönünde 60° döndürülmüş halini yanındaki 2. şekil üzerinde çiziniz ve cevabınızı açıklayınız.



1. şekil



2. şekil

12. Aşağıda verilen sözcüğün aynadaki görüntüsünü çiziniz.

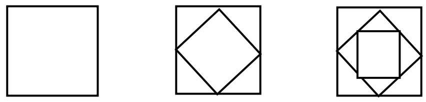
ANKARA

AYNA

13. Aşağıda ilk 3 adımı verilen şekillerden hangisi veya hangileri fraktal (şeklin orantılı olarak küçültülmüş ya da büyütülmüş halleri ile inşa edilmiş, her adımda aynı kural uygulanmış bir örüntü) hangileri değildir? Cevabınızı şekillerin altına açıklayınız.

a)

b)



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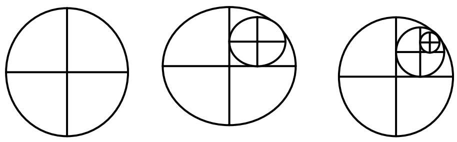
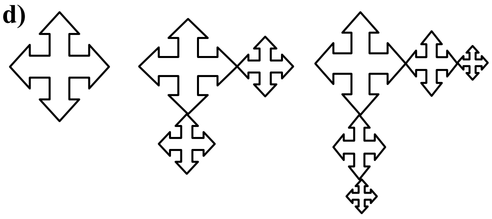
c)



d)



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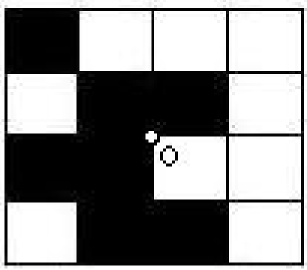
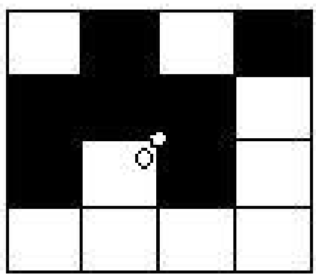
14.



Şekil-1



Şekil-2

Yukarıdaki merkezi "O" harfi ile gösterilen koordinat ekseninde, Şekil-1'i kullanarak Şekil-2'yi elde etmek istiyorsak, şekil-1'e nasıl bir dönüşüm hareketi uygulanmalıdır açıklayınız.