THE EFFECTS OF DRAMA BASED INSTRUCTION ON SEVENTH GRADE STUDENTS' GEOMETRY ACHIEVEMENT, VAN HIELE GEOMETRIC THINKING LEVELS, ATTITUDE TOWARD MATHEMATICS AND GEOMETRY

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ABSTRACT

THE EFFECTS OF DRAMA BASED INSTRUCTION ON SEVENTH GRADE STUDENTS' GEOMETRY ACHIEVEMENT, VAN HIELE GEOMETRIC THINKING LEVELS, ATTITUDES TOWARD MATHEMATICS AND GEOMETRY

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The aims of this study were to investigate the effects of drama based instruction on seventh grade students' achievement on geometry (angles and polygons; circle and cylinder), retention of achievement, van Hiele geometric thinking level, attitudes toward mathematics and attitudes toward geometry compared to the traditional teaching; to get the students' views related to the effects of drama based instruction on their learning, friendship relations, awareness of themselves, and the role of teacher and students; and to get the view of teacher who was present in the classroom during the treatment on drama based instruction.

The study was conducted on three seventh grade classes from a public school in the 2002-2003 academic year, lasting 30 lesson hours (seven and a half week).

The data were collected through angles and polygons; and circle and cylinder achievement tests, the van Hiele geometric thinking level test, mathematics and geometry attitude scale, and interviews.

The quantitative analyses were carried out by using two multivariate covariance analyses. The results revealed that drama based instruction had a significant effect on students' angles and polygons achievement, circle and cylinder achievement, retention of these achievement, van Hiele geometric thinking level, mathematics attitude, and geometry attitude compared to the traditional teaching.

According to the interview responses of the experimental group students and the classroom teacher, significantly better performance of the experimental group students was attributable to the potential of the drama based instruction to make learning easy and understanding better by; supporting active involvement, creating collaborative studying environment, giving chance to improvise daily life examples, giving opportunity to communicate, providing meaningful learning, supporting long-lasting learning and providing self-awareness.

Keywords: Mathematics education, drama based instruction, geometry achievement, van Hiele geometric thinking levels, attitude toward mathematics, and attitude toward geometry.

ÖZ

DRAMA TEMELLİ ÖĞRETİMİN YEDİNCİ SINIF ÖĞRENCİLERİNİN GEOMETRİ BAŞARISINA, VAN HIELE GEOMETRİK DÜŞÜNME DÜZEYLERİNE, MATEMATİĞE VE GEOMETRİYE KARŞI TUTUMLARINA ETKİSİ

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Bu çalışma drama temelli öğretimin, geleneksel öğretim yöntemiyle karşılaştırıldığında yedinci sınıf öğrencilerinin geometri (açılar ve çokgenler; ve daire ve silindir) başarılarına, bu başarıların kalıcılığına, van Hiele geometrik düşünme düzeylerine, matematiğe ve geometriye karşı tutumlarına etkisini araştırmayı; öğrencilerin dramanın öğrenmelerine, arkadaşlık ilişkilerine, ve kendilerine ilişkin farkındalıklarına, öğretmen ve öğrenci rollerine etkisi hakkındaki görüşlerini almayı; ve uygulama sırasında sınıfta bulunan öğretmenin drama temelli öğretimle ilgili görüşlerini almayı amaçlamıştır.

Çalışma bir devlet okulunda bulunan üç yedinci sınıf üzerinde 2002-2003 öğretim yılında gerçekleştirilmiş, 30 ders saati (yedi buçuk hafta) sürmüştür.

Veri toplamak amacıyla, açılar ve çokgenler; ve çember ve daire başarı testleri, van Hiele geometrik düşünme düzeyi testi, matematik ve geometri tutum ölçeği ve görüşmeler kullanılmıştır.

Elde edilen niceliksel veriler, yapılan iki çoklu kovaryans analizi ile incelenmiştir. Analiz sonuçlarına göre gruplar arasında açılar ve çokgenler; çember ve daire başarı testleri, bu başarıların kalıcılığı testi, van Hiele geometrik düşünme düzeyleri testi, matematik ve geometri tutum ölçeklerinden alınan puanlara göre deney grubu lehine istatistiksel olarak anlamlı bir fark bulunmuştur.

Deney grubu öğrencilerin ve deney grubundaki dersleri gözleyen öğretmenin görüşmelerde ifade ettikleri düşüncelere göre; deney grubu öğrencilerin kontrol grubu öğrencilerine göre daha iyi performans göstermesi drama temelli öğretimin aşağıdaki özellikleriyle ilişkilendirilmiştir: aktif katılımı gerektirmesi, grup çalışması ortamı yaratması, günlük hayat örneklerinin doğaçlanmasını içermesi, iletişim şansı yaratması, anlamlı öğrenmeyi sağlaması, kalıcı öğrenmeye yol açması, ve kendine ait farkındalığı sağlaması.

Anahtar Kelimeler: Matematik eğitimi, drama temelli öğretim, geometri başarısı, van Hiele geometrik düşünme düzeyleri, matematiğe karşı tutum, geometriye karşı tutum

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ABBREVIATION	
EG:	Experimental group
CG:	Control group
APA:	Angles and polygons achievement test
CCA:	Circle and cylinder achievement test
VHL:	Van Hiele geometric thinking level test
MAS:	Mathematics attitude scale
GAS:	Geometry attitude scale
MGP:	Mathematics grade in previous year
MOT:	Method of teaching
PREVHL:	Students' pretest scores on van Hiele geometric thinking level test
PREMAS:	Students' pretest scores on mathematics attitude scale
PREGAS:	Students' pretest scores on geometry attitude scale
POSTAPA:	Students' posttest scores on angles and polygons achievement test
POSTCCA:	Students' posttest scores circle and cylinder achievement test
POSTGAS:	Students' posttest scores on geometry attitude scale
POSTMAS:	Students' posttest scores on mathematics attitude scale
POSTVHL:	Students' posttest scores on van Hiele geometric thinking level test
DELAPA:	Students' delayed posttest scores on angle and polygon achievement test
DELCCA:	Students' delayed posttest scores on circle and cylinder achievement test
MANCOVA:	Multivariate analysis of covariance
ANCOVA:	Univariate analysis of covariance
Sig:	Significance
Df:	Degree of freedom

N:	Sample size
α:	Significance level

CHAPTER 1

INTRODUCTION

1.1 Importance of Geometry

Geometry has received a substantial attention since 2000 BC. Throughout the history, it has great importance in people’s lives with its origin in the need for human beings to specify quantities and to measure figures and lands. The widely known quote of Plato, "Let no man ignorant of geometry enter here” over the door of his academy can be given as an example of importance given to geometry (Burton, 1999; p. 79). The fact that Elements, the famous geometry book written by Euclid around 300 BC, has more editions than any other book except for the Bible can be another example (Malkevitch, 1998).

Nowadays, geometry still maintains its importance in mathematics curriculum. In order to represent and solve problems in other topics of mathematics and in daily life situations, sound geometry knowledge is necessary. It is also used in other disciplines such as science and arts. The National Council of Teachers of Mathematics (NCTM, 2000), the largest organization for teachers of mathematics in the world, has emphasized the importance of geometry in school mathematics by stating “geometry is a natural place for the development of students' reasoning and justification skills” (p. 40).

The significance of geometry, for anybody who does not plan to become a mathematician, is to develop visualization, reasoning abilities, and appreciation of the nature. Every human being from a housewife to an engineer needs some geometry intuition to understand and interpret the world.

Sherrard (1981) labeled geometry as a basic skill in mathematics that is significant for every student since; it is an important help for communication as geometric terms are used in speaking, it is faced in real life, it helps to develop spatial perception, learning geometry prepares students for higher mathematics courses and sciences and for a variety of occupation requiring mathematical skills, general thinking skills and problem solving abilities are facilitated by geometry, and studying geometry can develop cultural and aesthetic values.

1.2 The Need for Change in Geometry Instruction

Although much effort is used in teaching geometry, evidence from numerous researches makes it clear that many students are not learning geometry as they need or are expected to learn (Baynes, 1998; Burger & Shaugnessy, 1986; Clements & Battissa, 1992; Crowley, 1987; Fuys 1985; Fuys, Geddes, & Tischler, 1988; Mayberry, 1983; Mitchelmore, 1997; NCTM, 1989; Prescott, Mitchelmore, & White, 2002; Senk, 1985; Teppo, 1991; Thirumurthy, 2003; Ubuz & Ustün, 2003; Usiskin, 1982; van Hiele, 1986; van Hiele-Geldof, 1984).

Especially in Turkey, the students' geometry achievement is lower than the other areas of mathematics. In the Third International Mathematics and Science Study, the mathematics and science achievement of eighth-grade students in 38 countries were measured. Turkish students got the lowest mean scores from the geometry part of the test comparing to other four content areas of fractions and number sense; measurement; data representation, analysis and probability; and algebra. Of the 38 participating countries, Turkey was the eighth from the end in terms of the average of general mathematics achievement but it was the fifth from the end for the geometry part of the test (Mullis, Martin, Gonzalez, Gregory, Garden, O'Connor, Chrostowski, & Smith, 2000).

A need for increasing geometry achievement of students has been realized by mathematics educators (NCTM, 1989; NCTM, 2000). The needs and interest of today's children are far more different than the children of the past decades. The traditional instructional methods do not seem to be responsive to the potential of today's children (Battista & Clement 1999; Garrity, 1998; Schoenfeld, 1983).

Definitions of typical mathematics classroom involve phrases such as passive learners, rote learning, single predetermined ways to solution, paper and pencil tasks, and most importantly computational proficiency. The textbook drives classroom mathematics learning under the orchestration of the teacher (O'Connor, 1998). As Battista and Clement (1999) observed in many classrooms, mathematics was taught by using examples to explain students how to solve problems. Then letting the students solve similar problems. As a top down approach, generalizations, rules and definitions were given firstly then examples are shown. Similarly, Garrity (1998) stated that mathematics classes are commonly based on rote memorization of facts, teachers are lecturing and students are working countless problems from the book. Instruction is not designed to promote meaningful learning. Indeed, learning mathematics without understanding has been a problem of mathematics teaching (Skemp, 1976; Hiebert & Carpenter, 1992).

Generally, instruction in geometry has been teacher-centered, procedures-based, and prescriptive (Baynes, 1998; Keiser, 1997; Mayberry, 1983). This method is lacking in creativity, visualization, and conceptual development (Keiser, 1997; NCTM, 2000). Schoenfeld (1983) also supported the ideas that students cannot be creative enough in a traditional class. Furthermore, this approach was problematic for many students and teachers, and both groups considered geometry to be the most frightened subject (Malloy & Friel, 1999). As a consequence, it is not a surprise that many students lose interest in geometry.

Schoenfeld (1983) associated the limitations of traditional teaching in mathematics with the teacher-oriented instruction and “ready-made” mathematical knowledge presented to the students. Most formal school experience never gives students the opportunity to do anything with mathematics except for lean back and listen. Students should be given a chance to be involved in the teaching and learning process to learn meaningfully.

An important problem of today’s schools mentioned in Principles and Standards is disengagement of students from mathematics (NCTM, 2000). Students have become irrespective to the teachers; show negative attitude; and not value the mathematics in school. As a result of that, discipline problems have aroused in schools. If the ways we present mathematics are not consistent with the needs of students and appropriate to their interest we will still face the same difficulties in school.

As stated by Clements and Battissa (1992) what is needed more is to conduct teaching/learning research that leads students to get geometry concepts meaningfully and excitingly. During the last decade, researchers have studied on how geometry topics should be presented so that students' difficulties can be overcome. Many researchers have studied on using technology on geometry. Some of them studied on the effects of computer programs in geometry (Arcavi & Hadas, 2000; Baharvand, 2001; Bobango, 1988; Borrow, 2000; Chazan, 1998; Choi-Koh, 1999; Flanagan, 2001; Frerking, 1994; Furinghetti & Paola, 2002; Gerretson, 1998; Groman, 1996; Healy, 2000; Hodanbosi, 2001; Hölzl, 2001; Ives, 2003; Jones, 1998; Johnson, 2002; July, 2001; Kakihana, Shimizu & Nohda, 1996; Laborde, 1993; Laborde, 2002; Larew, 1999; Manouchehri, Enderson, & Pugnucco, 1998; Marrades & Gutierrez, 2000; Moss, 2000; Scher, 2002; Shaw, Durden & Baker, 1998; Sinclair, 2001; Thompson, 1993; Üstün, 2003; Washington-Myers, 2001) and some researchers conducted studies on usage of calculators in geometry (Din & Whitson, 2001; Dixon, 1997; Duatepe & Ersoy, 2002; Round, 1998; Ryan, 1999; Velo, 2001). These studies revealed that the use of technology is beneficial to students in developing their understandings of geometric concepts.

A different aid for geometry teaching other than technology is barely seen in the literature. Nichols and Hall (1995) studied on the effects of cooperative learning method in geometry lessons and found that it has positive effects. The effects of manipulative besides cooperative learning were investigated by Garrity (1998). This study pointed out that it improved the attitudes towards mathematics and achievement.

There still occurs a need to find different teaching methods in geometry instruction that meet the students' needs and make them engage in geometry to provide meaningful learning. Constructivist learning theory basically claims that in order for learning to be meaningful, learners should actively construct knowledge. The teacher should assist learning by creating a stimulating learning environment for students, asking questions that require students to think critically, and allowing them to investigate, discover and question the concepts they are learning. Considering these facts, this study proposes an alternative teaching method in geometry; drama based instruction.

Drama based instruction is an instructional method that allows students to improvise and construct a meaning of a word, a concept, an idea, an experience or an event by the utilization of theatre techniques and the play processes (San, 1996). This method creates an environment in which students construct their own knowledge by means of their experiences rather than imitating what has been taught (Bolton, 1986). They are assisted to build knowledge and discouraged to reproduce it. As they actively build their interpretations of the world, they have more ownership of their knowledge and thoughts. Concurrent with constructivists' view, cooperation with others is encouraged. Social negotiation promotes the construction of common interpretations of events and objects (Heathcote & Herbert, 1985). While the only communication way for students in a traditional classroom is listening; and students are passive receiver in those settings, drama offers a variety of communication experiences to students (Heinig, 1988; Southwell, 1999). In drama activities, students are encouraged to express their own ideas and to understand the messages of others by using both nonverbal and verbal communication.

In this method, the role of the teacher is the facilitator of students' exploration, development, expression and communication of ideas, concept and feelings rather than the direct information giver. According to Andersen (2000) in drama activities, teachers are not the one who knows everything or the experts. Rather than that, they share the construction of knowledge with students. Teachers control and guide activities, challenge and extent thought by taking a role just as students (Wilhelm, 1998). By this way, they can give an immediate feedback whenever it is necessary.

Since drama is a planned learning experience, teachers have the responsibility of designing, organizing and controlling the lessons (Heinig, 1988). Bolton (1988) stated that the students' activity would be akin to child play without the teacher in role. This means that the necessary intervention of the teachers should be made when necessary.

The most important responsibility of the teachers is to foster communication (Heinig, 1988). They must value and respect the sincere, open, and honest communication. Teachers' questioning is an encouraging way to communicate in drama. Additionally, teachers can encourage creative thinking abilities by providing an accepting environment in which students can try and fail and not afraid of taking risks and explore (Heinig, 1988).

Drama fosters many desirable cognitive and affective learning outcomes. When the literature on the effects of drama on the cognitive domain is investigated, it is seen that drama based instruction develops critical thinking skills (Bailin, 1998; De La Roche, 1993; Kelner, 1993; San, 1996), supports reflective thinking (Andersen, 2002; Neelands, 1984), stimulates the imagination and promotes creative thinking (Annarella, 1992; Bolton, 1986; Heinig, 1988; Kelner, 1993; Morris, 2001; San, 1996), improves achievement in different content areas (Farris & Parke, 1993; Kamen, 1992; Omniewski, 1999; Saab, 1987; Selvi & Öztürk, 2000; Üstündağ, 1997), promotes language developments (Heinig, 1988; Kelner, 1993), fosters decision making skills (De La Roche, 1993; San, 1996), promotes communication (Ballou, 2000; Bolton, 1985; Kelner, 1993; Yassa, 1999), strengthens retention (Annarella, 1992; Kelner, 1993; Omniewski, 1999; Southwell, 1999), promotes problem solving skills (Bolton, 1985; De La Roche, 1993; Heinig, 1988), and promotes ability to work cooperatively (Farris & Parke, 1993; Kelner, 1993).

The examination of the literature about the effects of drama on the affective domain revealed that it provides sensory awareness (Heinig, 1988; Bolton, 1988), brings confidence and enhances the students' self-esteem (Bolton, 1985; Drege, 2000; Porteus, 2003; Yassa, 1999), increases empathy and awareness of others (Annarella, 1992; Heinig, 1988; Kelner, 1993; Neelands, 1984; Yassa, 1999), and reinforces positive self-concept (Farris & Parke, 1993; Kelner, 1993).

Although the philosophical and theoretical foundations of drama and drama based instruction has been well discussed in many publications, there is not much empirical research in this area. Most of the above publications are not research-oriented studies. Furthermore, there are only few studies focused on the use of drama in mathematics education. Saab (1987) examined the effects of drama-based mathematics instruction on 87 sixth graders compared to textbook-oriented mathematics instruction. The results showed that drama based activities caused a significant increase in levels of mathematics achievement regarding mathematics computation. Attitudes toward mathematics and level of creativity were not affected by the use of drama based activities. Omniewski (1999) studied the effects of an arts infusion approach (in which music, art, dance, and drama were used) on the mathematics achievement of 49 second-grade students. Her aim was to determine whether a significant difference existed in mathematics achievement scores among an experimental group using an arts infusion approach, a control group using an innovative manipulative approach, and a control group using a traditional textbook approach. Groups were taught the mathematics concepts of patterning, sorting, classifying, and graphing by the same teacher for daily periods of 45 minutes for six weeks. All three groups were pre and post tested on mathematics achievement and the number patterns test. Results revealed that art infusion group surpassed the other two groups in gain scores on both immediate and delayed mathematics achievement tests. Southwell (1999), on the other hand, gave only examples of using dramatic moments to explore mathematical ideas, to challenge students and to develop conceptual understanding at the beginning, at the middle or at the end of the lesson.

Having established these facts, it seems necessary to design an experimental research on the effects of drama based instruction and to investigate its effects on students' geometry achievement, retention of geometry achievement, geometric thinking level, and mathematics and geometry attitudes compared to the traditional teaching.

1.3 The Research Questions

The research addresses the following questions;

1. What are the effects of the drama based instruction compared to traditional teaching method on seventh grade students' van Hiele geometric thinking level, attitudes toward mathematics, attitudes toward geometry, achievement on angles and polygons; and circle and cylinder when students' gender, mathematics grade in previous year, prior van Hiele geometric thinking level, attitudes toward mathematics and geometry are controlled?
2. What are the effects of drama based instruction compared to traditional teaching method on seventh grade students' retention of achievement on angles and polygons; and circle and cylinder when students gender, mathematics grade in previous year, the posttest scores on angles and polygons; and the circle and cylinder achievement tests, pre and posttest scores on van Hiele geometric thinking level test and mathematics and geometry attitude scales are controlled?

3. What are the students' opinions related to the effects of drama based instruction?

4. What are the opinions of classroom teacher, who was present in the experimental group during the treatment, related to the effect of drama based instruction?

1.4 Hypotheses

In order to answer the quantitative research problems the following hypotheses were used;

Null Hypothesis 1:

$H_{0[1,2,3,4,5]} : \mu_{DBI} - \mu_{TT} = 0$

1: students' posttest scores on angles and polygons achievement test, 2: students' posttest scores on circle and cylinder achievement test, 3: students' posttest scores on van Hiele geometric thinking level test, 4: students' posttest scores on mathematics attitude scale, 5: students' posttest scores on geometry attitude scale.

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the collective dependent variables of the seventh grade students' posttest scores on angles and polygons achievement test, circle and cylinder achievement test, van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 2:

$H_{0[1]} : \mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' posttest scores on angle and polygon achievement test, when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 3:

$H_{0[2]} : \mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' posttest scores on circle and cylinder achievement test, when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 4:

$H_{0[3]} : \mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' posttest scores on van Hiele geometric thinking level test, when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 5:

$H_{0[4]} : \mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' posttest scores on mathematics attitude scale, when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 6:

$H_{0[5]} : \mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' posttest scores on geometry attitude scale, when students' gender, mathematics grade in previous year, pretest scores on van Hiele geometric thinking level test, mathematics attitude scale, and geometry attitude scale are controlled.

Null Hypothesis 7:

$H_{0[6,\ 7]}$: $\mu_{DBI} - \mu_{TT} = 0$

6: students' delayed posttest scores on angles and polygons achievement test,

7: students' delayed posttest scores on circle and cylinder achievement test.

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the collective dependent variables of the seventh grade students' delayed posttest scores on angles and polygons achievement test, and circle and cylinder achievement test, when students gender, mathematics grade in previous year, the posttest scores on angles and polygons achievement test and the circle and cylinder achievement test, pre and posttest scores on van Hiele geometric thinking level test and mathematics and geometry attitude scales are controlled.

Null Hypothesis 8:

$H_{0[6]}$: $\mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' delayed posttest scores on angles and polygons achievement when students gender, mathematics grade in previous year, the posttest scores on the angles and polygons achievement test, and the circle and cylinder achievement test, pre and posttest scores on van Hiele geometric thinking level test and mathematics and geometry attitude scales are controlled.

Null Hypothesis 9:

$H_{0[7]}$: $\mu_{DBI} - \mu_{TT} = 0$

There will be no significant effects of methods of teaching (drama based instruction versus traditional teaching method) on the population means of the seventh grade students' delayed posttest scores on the circle and cylinder achievement test, when students gender, mathematics grade in previous year, the posttest scores on the angles and polygons; and the circle and cylinder achievement tests, pre and posttest scores on van Hiele geometric thinking level test and mathematics and geometry attitude scales are controlled.

1.5 Definition of the Important Terms

The terms used in this study can be defined as follows;

Mathematics grade in previous year: Students' mathematics grades at their sixth grade report cards. This information was obtained from school administration.

Drama based instruction: Drama based instruction is an exploratory and experiential approach to learning that involves the interaction of mind and knowledge; sensory and kinesthetic experiences; evaluation and decision making; understanding of the how, the why and why not of complex issues (Martin-Smith, 1993). It creates student focused as-if worlds that embed problems within situations where meaningful learning is fostered. As active learners, students construct their own knowledge by means of their experiences rather than just absorbing what is given. It presents opportunities for students to respond and interact in imaginative situations with their whole being (Wagner, 1985). Students have chances to engage in the process of abstraction and generalization in the ways of using their bodies and imagination. The collaborative aspect of drama based instruction promotes communication among students and between students and teacher. The role of the teacher is the facilitator of students' exploration, development, expression and communication of ideas, concepts and feelings rather than the direct information giver.

The traditional instruction environment: It is based on a textbook approach, using chapters of a textbook related to topics. It is teacher-centered and involves lecturing and sometimes questioning. Generalizations, rules and definitions are given firstly as a top down approach, and then examples are provided. The students listen and take notes in their own places.

1.6 Significance of the Study

The purposes of this study were to examine the effects of drama based instruction on seventh grade students' geometry achievement; geometric thinking level; attitudes towards mathematics and geometry; and retention of achievement compared to the traditional teaching; to get the students' views related to the effects of drama based instruction on their learning, friendship relations, awareness of themselves, and the role of teacher and students; and to get the view of teacher who was present in the classroom during the treatment on drama based instruction.

There is a wealth of publications explained the advantages of using drama in education settings. However, few of them focused on drama based instruction in mathematics and presented results of an empirical study. Considering this fact, there is a need to design an experimental study on drama based instruction in mathematics and to report the benefits of drama based instruction determined by quantitative measures. On the other hand, quantitative and qualitative tools can serve complementary functions: qualitative investigation can be used to answer the question of "how drama brings its benefits" after answering quantitative questions. Therefore, combining quantitative and qualitative data provides a more complete picture of the issue. From this perspective, this study will bring illumination and give deep explanation on the effects of drama based instruction in mathematics.

As stated previously, the use of drama in mathematics education is barely seen. This situation brings the question of "Is it possible to use drama in mathematics education?" This research will offer an answer to this question.

This study is a rudiment to develop different and appropriate drama lesson plans in mathematics. The lesson plans developed in the study will be very helpful for future mathematics teachers and researchers as there is no drama based geometry lesson plans.

Findings will be significant in validating the use of drama based instruction in geometry. Information derived from this study can serve as foundations for development of curricular considerations. The curriculum developers might modify the curriculum according to the outcomes of the study. For example drama based lessons will be suggested in elementary grades. Moreover, preservice teacher education might be affected with the result of the study. Drama training will be offered for the preservice teachers.

1.7 Assumptions

2. All tests were administered to the experimental and control group under the same standard conditions.
3. The subjects of the study were sincere while responding to the test items and interview questions.
4. Students from different classes did not interact and communicate about the items of post and delayed achievement tests before administration of these tests.
5. The differences of implementers have no effect on the results of the study.

1.8 Limitations

1. The study was not a true experimental study since subjects were not randomly assigned to the experimental and the control group.
2. The results of the study are limited to the population with similar characteristics.
3. The students' prior achievement was not taken into consideration. Instead, the prior van Hiele thinking level and mathematics grade in previous year were assessed. Researches (Fuys, Geddes, & Tischler, 1988; Senk, 1989; Shaughnessy & Burger, 1985; Usiskin, 1982) have revealed that students' van Hiele level is a good predictor of the students' achievement on geometry.

CHAPTER 2

REVIEW OF THE RELATED LITERATURE

2.1 Geometry

Geometry is our human heritage from all cultures (Hartfield, Edwards, & Bitter, 1997). It has a prominent place in mathematics curriculum as well (Keiser, 1997). School geometry allows students to develop insight to understand other mathematical concepts and connect ideas across different areas of mathematics (Mammana & Villiani, 1998; Muschla & Muschla; 2000; NCTM, 2000). In addition to the value of geometric ideas in understanding other areas of mathematics, it is helpful to make the students realize the beauty of mathematics (Serra, 1993). Another reason of the importance of geometry is that many ideas like symmetry or generalization can help students increase insights into the nature and beauty of mathematics (NCTM, 2000). Furthermore, geometry knowledge is very useful to solve everyday life problems like measurement of lengths, drawing, reading maps, etc. (Bussi & Boero, 1998; Kenney, Bezuszka, & Martin, 1992). Therefore geometry knowledge is very useful not only inside the school but also outside the school. As NCTM (2000) summarized that while students engage with the topics of geometry, they gain an understanding both the spatial world and other topics in mathematics and in art, science, and social studies.

2.2 Development of Geometry Concept

Piaget and Inhelder (1956) suggested that a child's representation of space is constructed through social interaction and active engagements with their surroundings. According to them, the children's geometric thought progresses through the following sequence: topological relationships (connectedness, enclosure and continuity), projective relationships (rectilinerity) and Euclidean relationships (angularity, parallelism and distance) (Piaget &

Inhelder, 1956). They claimed the progression through these four steps is the result of the followings; an individual's maturation, social interaction, actions on the surroundings (either physical or mental), and the disagreement with disequilibrium and following resolution of the conflict by the processes of assimilation and accommodation.

Similarly, van Hiele (1986) constructed a model that explains the stages of human geometric reasoning. The van Hiele model of geometric thinking appears similar in structure to Piaget's developmental stages, but the properties of these two models are different.

2.3 Van Hiele Geometric Thinking Levels

According to van Hiele (1986), all human being progresses through five stages named as visual level, descriptive level, theoretical level, formal logic and the nature of logical laws.

2.3.1 Level 0 (The Visual Level):

Students first learn to recognize a shape by its appearance as a whole or through some physically qualities such as "fatness", "pointiness", etc. They cannot notice the properties of components. If students are introduced to a certain shape, then they are able to name when they see it again but without giving explanations concerning properties of its parts. For example, they may believe that a given figure is a rectangle because "it looks like a picture frame."

Fuys, Geddes and Tischler (1988; p. 58-59), identified the descriptors for this level as follows;

Students at this level;

1. identifies instances of a shape by its appearance as a whole
    a. in a simple drawing, diagram or set of cut-outs,
    b. in a different positions,
    c. in a shape or other more complex configurations,
2. constructs, draws, or copies a shape,

3. names or labels shapes and other geometric configurations and uses standard and/or nonstandard names and labels appropriately,
4. compares and sorts shapes on the basis of their appearance as a whole,
5. verbally describes shapes by their appearance as a whole,
6. solves routine problems by operating on shapes rather than by using properties, which apply in general,
7. identifies parts of a figure but
   a. does not analyze a figure in terms of its components.
   b. does not think of properties as characterizing a class of figures.
   c. does not make generalizations about shapes or use related language.

2.3.2 Level 1 (The Descriptive Level)

At descriptive level, students reason about geometric concepts by means of an informal analysis of their parts and properties. These properties could be realized by a variety of activities such as observation, measuring, cutting, and folding. At this level necessary properties of the figure could be understood. For example, the student knows the properties of a square such as; a square has four congruent sides; a square has congruent diagonals; a square has four right angles; the diagonals of a square bisect each other; the diagonals of a square are perpendicular; opposite sides of a square are parallel. However each property is perceived as isolated and unrelated, no property implies any other. Therefore, relations between properties and definitions are not understood. According to Fuys et al., (1988; p. 60-63), the descriptors for this level are as follows;

Students at this level;

1. identifies and tests relationships among components of figures,
2. recalls and uses appropriate vocabulary for components and relationships,
3. a. compares two shapes according to relationships among their components,
   b. sorts shapes in different ways according to certain properties, including a sort of all instances of a class from non-instances,
4. a. interprets and uses verbal description of a figure in terms of its properties and uses this description to draw/construct the figure,

b. interprets verbal or symbolic statements of rules and applies them,

5. discovers properties of specific figures empirically and generalizes properties for that class of figures,

6 a. describes a class of figures (e.g., parallelograms) in terms of its properties,

b. tells what shape a figure is, given certain properties,

7. identifies which properties used to characterize one class of figures also apply to another class of figures according to their properties,

8. discovers properties of an unfamiliar class of figures,

9. solves geometric problems by using known properties of figures of figures or by insightful approaches,

10. formulates and uses generalizations about properties of figures (guided by teacher / material or spontaneously on own) and uses related language (e.g., all, every, none) but

a. does not explain how certain properties of a certain figure are interrelated.

b. does not formulate and use formal definitions.

c. does not explain subclass relationships beyond checking specific instances against given list of properties.

d. does not see a need for proof or logical explanations of generalizations discovered empirically and does not use related language (e.g., if-then, because) correctly.

2.3.3 Level 2 (The Theoretical Level)

Students logically order the properties of concepts, form abstract definitions, and distinguish between the necessity and sufficiency of a set of properties in determining a concept. The relationship between properties can be seen, hierarchies can be built and the definitions can be understood, properties of geometric figures are deduced one from others. For example, the student can see that a square is a rectangle; but a rectangle may not be a square. However, the importance of deduction cannot be understood at this level. According to Fuys et al., (1988; p. 64-68), the descriptors for this level are as follows;

Students at this level;

1. identifies different sets of properties that characterize a class of figures and test that these are sufficient,
a. identifies minimum sets of properties that can characterize a figure,
b. formulates and uses a definition for a class of figures,
2. gives informal arguments (using diagrams, cutout shapes that are folded, or other materials),
a. justifies the conclusion using logical relationships, having drawn a conclusion from given information.
b. orders classes of shapes.
c. orders two properties.

2.3.4 Level 3 (Formal Logic)

This level is treated as the essence of mathematics by van Hiele (1986) since thought on this level is concerned with deduction. Students at this level reason and organize proofs logically. They can construct proofs of theorems, understand the role of axioms and definitions, and the meaning of necessary and sufficient conditions. As the proof is constructed rather than memorized, it is not forgotten thereby can be reconstructed. Students understand the fact that the definition of "quadrilaterals in which all sides and angles are equal" and the definition of "quadrilaterals in which all angles are perpendicular and adjacent sides are equal" could be proved to be equal and both can define a square. According to Fuys et al., (1988; p. 69-70), the descriptors for this level are as follows;

Students at this level;

1. recognizes the need for undefined terms, definitions, and basic assumptions (e.g., postulates),
2. recognizes characteristics of a formal definition (e.g., necessary and sufficient conditions) and equivalence of definitions,
3. proves in axiomatic setting relationships that were explained informally on level 2,
4. proves relationships between a theorem and related statements (e.g., converse, inverse),
5. establishes interrelationships among networks of theorems,

6. compares and contrasts different proofs of theorems,
7. examines effects of changing an initial definition or postulate in a logical sequence,
8. establishes a general principle that unifies several different theorems,
9. creates proofs from simple sets of axioms frequently using a model to support arguments,
10. gives formal deductive arguments but does not investigate the axiomatic themselves or compare axiomatic systems,

2.3.5 Level 4 (The Nature of Logical Laws)

Students compare different geometries based on different axioms and study them without concrete models. They can establish consistency of a set of axiom, and equivalence of different sets of axioms, create an axiomatic system for a geometry. Theorems in different axiomatic systems could be established. According to Fuys et al., (1988; p. 71), the descriptors for this level are as follows;

Students at this level;

1. rigorously establishes theorems in different axiomatic systems (e.g., Hilbert's approach to foundations of geometry),
2. compares axiomatic systems (e.g., Euclidean and non-Euclidean geometries); spontaneously explores how changes in axioms affect the resulting geometry,
3. establishes consistency of a set of axioms, independence of axiom, and equivalency of different sets of axioms; creates an axiomatic system for a geometry,
4. invents generalized methods for solving classes of problems,
5. searches for the broadest context in which a mathematical theorem/principle will apply,
6. does in-dept study of the subject logic to develop new insights and approaches to logical inference.

To sum up, the first level geometric thinking begins with nonverbal thinking. The student at level 0 perceives a figure as a whole shape and does not perceive their parts. He/she might say, "It is a rectangle because it looks like a door". At level 1, properties can be recognized but properties are not yet logically ordered. At level 2, properties are logically ordered; one property precedes or follows from another property. But at this level, the intrinsic meaning of deduction, that is, the role of axioms, definitions, theorems, and their converses are not understood. At level 3 deduction and construction of proof can be understood. Different axiomatic systems can be understood at level 4. This model has been studied and validated by numerous researchers (Burger & Shaughnessy, 1986; Fuys, Geddes & Tischler, 1988; Hoffer, 1981; Mayberry, 1981; Moody, 1996; Moran, 1993; Senk, 1983; Senk, 1989; Usiskin, 1982; Villiers & Njisane, 1987).

2.3.6 Properties of van Hiele Geometric Thinking Levels

As van Hiele (1986) stated geometric thinking levels have the following properties;

Levels are sequential. That is, one cannot be at van Hiele level n without having gone through n-1 and earlier. The student can, however, be thought to stimulate a level by performing algorithmically on that level. This was named as reduction of levels. In this case, the student is often applying rules that he does not understand and may consider arbitrary. For example a student just copies a proof without mastering level 3, memorizes properties of a figure without understanding before mastering level 1.

Progress from one level to the next level depends more on the content and methods of instruction than on age or biological maturation. A teaching-learning process is necessary to move the student from one level to the next.

Each level has its own linguistic symbols and its own structure connecting those symbols. While talking on geometry, two people reason at different levels cannot understand each other. If instruction assumes the student is one level while the student is on a lower level, communication problems between the instruction and the student will appear.

The products of the activities at one level become the objects of study at the next level. At each level of thought, what was intrinsic in the preceding level becomes extrinsic. In other words, the object of perception at the previous level becomes the object of thought or study at the next level (Mayberry, 1981). According to Fuys et al., (1988), objects of thoughts at level 0 are geometric figures. At level 1, classes of figures, which are the outcome of the level 0, are the objects of thoughts. By this level students begin to discover the properties of figures. The properties of the figures become objects of thought at level 2. Objects of thought of the level 3 are the ordering relations of the properties of figures. At level 4, the objects of thoughts are the foundation of these ordering relations.

2.4 Students' Understanding of Angles

Clements and Battista (1992), Krainer (1991), and Mitchelmore (1997) pointed out that the concept of angle has a prominent place in development of geometric knowledge. In the book of The Child's Conception of Space, Piaget and Inhelder (1956) suggested that angle is quite complex concept for student in the early grades of elementary school. The multifaceted nature of this concept makes it a difficult concept for students (Mitchelmore & White, 2000). Students generally lack of understanding of angle concepts and held many misconceptions about angles (Fuys, Geddes & Tischler, 1988; Kopelman, 1996; Matos, 1999; Mitchelmore & White; 2000; Prescott, Mitchelmore, & White, 2002; Scally, 1991; Ubuz, 1999).

Mitchelmore and White (2000) suggested that students initially be familiar with apparent similarities between angle experiences and form separate angle concepts based on physical angle situation such as roof, road junction, hills and tiles. After that they recognize profound similarities between these situations and form angle concepts related to physical angle context like corner, slope and turn. In the last step, students identify even deeper similarities between contexts and form an abstract angle concept that gradually generalizes to include all angle contexts.

Scally (1991) carried out a study on ninth grade students conceptions of angle and showed that the students' conceptions of angles were prototypical. Students generally drew angles with one arm oriented on a horizontal line. They tended to draw right angles and acute angles when they were asked to draw arbitrary angles. Few numbers of students drew obtuse angles, and very few ever drew straight angles. The right angles they drew were most often oriented to face toward the right hand edge of the page. Students gave the standard representations of angles that presented in most textbooks. Many students ignored relevant attributes, such as straightness. They seemed to focus on only one attribute rather than all attributes necessary for accurate identification of angles. Related with the size of angles, many students were considered the length of rays as size of angle. Very few numbers of students understand the relations between the properties of angles. Some students identified angles as polygons such as triangle and rectangle.

Fuys et al., (1988) conducted a research on students understanding of angle. They showed that students have limited vocabulary about angle. For example instead of the word “angle”, they used the some other words like “slanty”, “point”, “vertex”, and “triangle”. Another finding was that orientation of the angles also affected the students’ perceptions. For example, students could not identify a right angle unless one of its sides was vertical and the other was horizontal. Other misconception about the right angle was that some students believed that all right angles point to the right and that all angles needed to have one ray that was horizontal.

Kopelman (1996) also studied on the conceptions of angle. He found that top-ability 12^{th} grade students, experienced mathematics teacher and professional mathematician have difficulties in applying the notions of angle. He asked the question of “given a space and a point outside the line, how many planes in space may be drawn through this point which make an angle of thirty degrees with the given line?”. None of the subjects felt the need in calculations, they relying upon imagination, or their own drawings. Almost all of the respondents were responded wrongly as assuming only two possible angles could be drawn.

Keiser (1997) studied on sixth-grade students' understandings of angle concepts and found out students' understandings of angle concepts are disconnected and fragile. Student concept images of angle tended to focus on one of the three qualities of the angle: its ray, its vertex, or its interior. Students easily identified some of the angles but not some sorts. For example, while the interior angles of convex polygons easily identified, angles found in the exteriors of polygons, interior angles of a polygon that are greater than 180˚ are not easily identified. To determine the size of an angle, some students focus on the length of the ray, the linear distance between two rays or the amount of space or area between two rays. Students tend to focus on one of three aspects--the angle's vertex, its rays, or its interior region. When comparing angle measures of two angles, students would often use the words “narrower” and “wider”, which were also used in place of “acute” and “obtuse”. Students often used the words, “side”, “edge”, “vertex”, “point”, and “angle” interchangeably.

Ubuz (1999) investigated tenth and eleventh graders understanding of angles according to their errors, misconceptions and gender. She found that students had misconceptions on special angles constructed between a pair of parallel lines cut by a transversal. She suggested that the reasons of students’ difficulties can be summarized as follows: students assumed something was given by looking at the figures, they focused on the figure itself rather than its properties, and they did not know the meaning of exterior and interior angles of a triangle.

Matos (1999) carried out a study to investigate the ways of the geometrical concept of angle are understood by individual students, and to analyze the contexts involved in this understanding. He studied on the concept of angle in 16 fourth and fifth graders. His aims were to identify and categorize the students' cognitive models and relate them to the van Hiele levels. According to findings students' concepts of angles were grounded particularly in image schemas produced by intrinsic bodily experiences with objects (corners, points), actions performed on objects (opening, turning), actions performed by objects (opening, pouring), or actions performed in relation to objects (going around). According to him, when students refer to angles in general, the images of acute and right angles came to their mind.

Prescott, Mitchelmore, and White (2002) interviewed with eight third grade students on the concept of angle. They found that students’ difficulties could be classified as matching, measuring, drawing and describing errors. According to findings students who could not match the angle in a new context (e.g. doors) with the angle in an existing context (e.g. pattern blocks) would not have identified in the new context the two lines, the vertex, and the opening which are the essential features of an angle. Students had difficulties in isolating the linear parts of a concrete object that form the arms of the angle. Many objects, which form the arms of an angle, did not look like lines at all for the students. They could only come to be regarded as lines when the child recognizes the angular similarity between the situation where they occur and a more familiar situation that is known to involve angles and where the lines may be more obvious. Once students recognized that a context involves angles, they seemed to have little difficulty with measuring angle size.

2.5 Students' Understanding of Polygons

Hershkowitz and Vinner (1983), and Hershkowitz, Vinner and Bruckheimer (1987) investigated concept images of students (grades five to eight) and teachers on the concepts of polygons. They found out that each geometry concept has one or more prototypical examples. Students generally attained those prototypical examples; furthermore most of the students had those prototypical examples as the concept image. Matos (1999) claimed that prototype effect is that judging that certain members of a category are more representative of the category than others. According to Hershkowitz (1987) prototypes are generally a visual and found that students formed one or more prototypical examples composed of the critical attributes of the concept together with specific noncritical attributes that have strong, salient, visual characteristics.

Fuys et al., (1988) showed that some sixth-grade students described a rectangle based on its appearance. Other students described it according to its properties. Still other students described a rectangle as a special type of parallelogram.

Prevost (1985) studied on identifying and defining polygons with seventh and eight grade students. According to findings, students were not able to identify common figures of rectangles, squares and trapezoids. Almost all the students could not identified oriented figures different from anything they had seen before. Almost all the students could parrot the definition they had learned otherwise their definition was included the phrase of “looks like”. Wilson (1983) investigated the relationships between the way students define the rectangle and their choice of example. She found that the students' choice of examples was based on their own prototypes not on their definitions.

Burger and Shaughnessy (1986) interviewed with students from kindergarten to college on their understanding of polygons. According to their findings, students gave visual prototypes to characterize polygons, when identifying polygons they considered irrelevant attributes such as orientation of the figure. Students could not determine the necessary properties to define a shape. They sorted polygons by considering single attribute and prohibited class inclusions among polygons.

Tsamir, Tirosh and Stavy (1998) investigated the ways students' comparing various characteristics of polygons. As they found out students at various grade levels argued that the equality of the sides and the equality of the angles in any polygon are linked. They claimed that this condition directed students to wrong conclusions.

Ubuz (1999) examined tenth and eleventh grade students' understanding of basic geometry concepts and showed that students did not know the meaning of a triangle and the properties of exterior and interior angles of a triangle. They thought that trapezoid as a parallelogram without thinking its properties. Another finding related with polygons was that students applied the properties of regular polygons to any non-regular pentagon.

Previous studies also found out that students have difficulties of hierarchical classification of polygons (Burger & Shaughnessy, 1986; Duatepe, 2000b; Fuys et al., 1988; Usiskin, 1982). Some other studies revealed that students' choice of examples of geometric concepts and their definitions of the same concepts do not match (Fuys et al., 1988; Hershkowitz, Vinner, & Bruckheimer, 1987; Prevost, 1985; Shaughnessy & Burger, 1985; Vinner & Dreyfus, 1989; Vinner, & Hershkowitz, 1980; Wilson, 1983).

Several studies revealed that a preferred position for the polygons has a horizontal base (Fuys, 1985; Presmeg, 1992; Scally, 1991; Vinner & Hershkowitz, 1983).

2.6 Students' Attitudes toward Mathematics and Geometry

Attitude is a learned pattern of manners that is developed through one's environment (Thompson, 1993). It represents one's feelings toward a given circumstances and affect one's reaction to a particular situation. Aiken (1976) defined attitude as a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, condition, or concept. According to McLeod (1992), attitude is the positive or negative degree of affect associated to a certain subject.

Attitudes related to mathematics include liking, enjoying, and interest in mathematics, or the opposite, and at worst math phobia (Ernest, 1989). Ma and Kishor (1997) offered the definition of attitudes toward mathematics as an aggregated measure of liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless (p. 27).

Attitude is often considered in educational research since the development of a positive attitude is desirable because of its association with achievement (Nkwe, 1985). Ma and Kishor (1997) indicated there is a general belief that children learn more effectively when they are interested in what they learn and that they will achieve better in mathematics if they like mathematics. On the other hand, the previous studies have not provided consistent findings concerning the relationship between attitude toward mathematics and mathematics achievement. A number of researchers have demonstrated that there is a significant correlation between attitude and achievement (Aiken, 1976; Davis, 2002; Haladyna, Shaughnessy, & Shaughnessy, 1983; Kulm, 1980; Ma, 1997; Ma & Kishor, 1997; Schoenfeld, 1989; White, 2001). However it cannot be concluded that positive attitude always causes high achievement in mathematics. For example, Kiely (1990) showed that on average a small number of pupils who were not good enough in mathematics obtained high scores in the attitude test. Another study suggested that extremely positive or negative attitudes tend to predict mathematics achievement better than more neutral attitudes (cited from Bergeson, Fitton, & Bylsma, 2000).

Ma and Kishor (1997) conducted a meta-analysis on 113 studies on relation between attitude and achievement of mathematics. They found that the overall mean effect size was statistically significant, relatively weak at the primary school and stronger at the secondary school level. Ma and Kishor (1997) also found that many children begin schooling with positive attitudes toward mathematics; these attitudes, however, tend to become less positive as children grow up, and frequently become negative at the high school.

As cited by Bergeson, Fitton, and Bylsma (2000), students develop positive attitudes toward mathematics when they see mathematics as useful and interesting. Similarly, students develop negative attitudes toward mathematics when they do not do well or view mathematics as uninteresting. The development of positive mathematical attitudes is linked to the direct involvement of students in activities that involve both quality mathematics and communication with significant others within a clearly defined community such as a classroom.

The middle grades are the most critical time period in the development of student attitudes toward mathematics. Student attitudes toward mathematics are quite stable, especially in Grades 7–12 (Bergeson, Fitton, & Bylsma, 2000).

In the case of geometry, Thompson (1993) showed that the curriculum in which students learned geometry have an impact on students' feelings and believes toward mathematics. Capraro (2000) found out that attitude toward mathematics has a positive strong relation with the geometry content knowledge.

2.7 Drama and Drama Based Instruction

Contrary to common belief, drama is a learning medium rather than an art form. The major difference between theatre and drama is that, drama is informal and focuses on the process of dramatic enactment for the sake of the learner, not an audience (Heinig, 1988). According to Way (1967) theatre is largely concerned with communication between actors and audience, drama is largely concerned with experience of the participants, irrespective of any function of communication to an audience. To emphasize this difference, Farris and Parke (1993) used the terms process-centered drama and audience-centered theatre. The word 'process' usually indicates an ongoing event, unlike product, a term that implies conclusion, result, and a finished object (Andersen, 2002). The spontaneous self-expression of the individual is the important outcome of the drama. This process allows the participants to synthesize and to translate concepts into a personally meaningful form. Therefore unlike theatre, product is not the major goal in drama, emphasize is on the process (Fransen, 2003; Heinig, 1988; Kelner, 1993; Kitson & Spiby, 1997; Porteous, 2003).

Another difference between drama and theatre is that the drama process is not scripted as theatre; therefore it cannot be memorized. Since the process is spontaneous and not rehearsed, it is often crudely performed. A polished performance is not the goal of drama because it is not meant to be seen by an audience. Acting or playing is not end itself but a means of exploring different concepts and behaviors. Therefore participants need not to act as a professional actors or actress, because the success of the activity is not measured by the level of theatrical skill (Kelner, 1993).

As cited by Heinig (1988), American Alliance for Theatre and Education defined drama as an improvisational, nonexhibitional, process centered activity in which participants are guided by a leader to imagine, enact, and reflect upon human experiences. Fransen (2003) defined drama as an activity based on improvisation that is process-centered and used primarily for the personal development of the participants.

When used as a method of learning, drama involves the interaction of mind and information; sensory and kinesthetic experiences; evaluation and decision making; understanding of how, why and why not of complex issues (Martin-Smith, 1993).

Drama based instruction is a pedagogical method, which focuses on the learning process of the participant rather than polished performance for an audience. It is an exploratory and experiential approach to learning. According to San (1996), drama based instruction is an instructional method for allowing students to improvise and construct a meaning of a word, a concept, an idea, an experience or an event by the utilization of theatre techniques and the play processes. The term improvisation is the spontaneous use of movement and speech to create a character or an object in a particular situation (Gallagher, 1997).

Briefly, drama based instruction is an inquiry method of learning involves interaction and communication of students based on their sensory and kinesthetic experiences.

The “play way” of learning had become popular with the theory of “learning by doing” (Dewey, 1938). Dewey recognized the need to make learning meaningful. He also realized the usefulness of arts as representative of human experience, not to be separate from or “above” other subjects, but as a central part of learning. In his book, he mentioned child centered education and pointed to change the center of the education from teacher to students. He mentioned about “learning by doing” which can be reckoned as the roots of drama based instruction. He stressed on the experience in learning and development. Drama based instruction theory provides opportunities to “do” and to “play”.

Piaget indicated that dramatic play is directly related to the children’s thought (Piaget, 1959). As he proposed the cognitive structure has two processes: assimilation and accommodation. Play assimilates new experience to cognitive structure that is also called schema. If the new information is completely new and there is no existing schema to incorporate it into, or contradicts the existing schema, then this must be accommodated so that the new information may fit. As a result, new interconnections can be made. The drama based instruction involves plays that can help children test out thoughts and concepts and by so doing make sense of them through assimilation and accommodation (Kitson & Spiby, 1997).

In drama based lessons, the classroom environment is a kind of open classroom of the humanistic approach of education founded by Rogers (1983). The climate of acceptance, psychological freedom and open communication are provided; and different ideas, behaviors, feelings, values, and even mistakes of the students are accepted. Self-actualization, students’ choice and decision are encouraged. There is mutual trust and respect that are essential characteristics for learning and development of self-esteem, in drama based lessons (Heinig, 1988; Kitson & Spiby, 1997). When students thrust, they can freely express themselves. The more students feel comfortable, the more they learn. Because of this, setting the appropriate atmosphere for the drama based activities is important. Therefore a flexible environment should be created so that students feel themselves in a comfortable environment to trust each other and participants. Rogers (1983) differentiated two types of learning: cognitive (meaningless) and experiential (significant). The key to the distinction between these two is that experiential learning addresses the needs and desires of the learner. According to him all human beings have a natural inclination to learn; the role of the teacher is to facilitate such learning.

Roger (1983) stated that significant learning occur when the subject matter is relevant to the personal interests of the student. Learning which is challenging to the self (e.g., new attitudes or perspectives) is easily assimilated when external threats are at a minimum. The most lasting and pervasive learning is self-initiated learning.

In drama based instruction, the role of the teacher is the facilitator of students' exploration, development, expression and communication of ideas, concept and feelings rather than the direct information giver (Fransen, 2003; Heinig, 1988; Morgan & Saxton, 1987; Wilhelm, 1998).

According to Andersen (2000), in drama based activities; teachers are not the one who knows everything or the experts. Rather than that, they should share the construction of the knowledge with the students. Wilhelm (1998) stated that the teacher becomes a learner among learners, a participant, and a guide, who lends expertise to the students drama based lessons.

Teachers can also control and guide activities, challenge and extent thought by taking role just as students (Wilhelm, 1998). By this way, they can give an immediate feedback when it is necessary. In this case, the communication bond is stronger than simply observing (Heinig, 1988). Besides providing an effective relationship and interaction for the teacher, taking role also provides the controlling what students do. Since drama based instruction is a planned learning experience, the teacher has the responsibility of designing, organizing and controlling the lessons (Heinig, 1988). Bolton (1998) stated that without the teacher in role the students' activity would be similar to child play. This means that the teacher's intervention is needed in drama activities whenever necessary.

The most important responsibility of the teacher is to foster communication (Heinig, 1988). They must value and respect sincere, open, and honest communication of the students. Teachers questioning is an encouraging way to communicate in drama based instruction. They should ask real questions, which can encourage the students more deeply into their thinking. The typical teachers' questions that indicate to the student that the teacher knows the answers are avoided (Tarlington, 1985).

As Kitson and Spiby (1997) stated most of all, teachers have responsibility to make the drama interesting for the children. Because drama based instruction is student-centered; it begins with the student (Courtney, 1990; Heinig, 1988; Wilhelm, 1998). Students are active participants to the learning. As Neelands (1984) suggested, “drama is dialectic rather than didactic form of learning (p.54)”. They become a part of learning process rather than only observers or passive receivers of the rich experience of learning. Therefore their learning is deeper, and long lasting.

This method creates an environment in which students construct their own knowledge by means of their experiences rather than imitating what has been taught (Bolton, 1986). As they actively build their interpretations of the world, they have more ownership of those thoughts. Concurrent with the constructivists’ view, student builds their own knowledge of the world from their perceptions and experiences (Simon, 1995).

Cooperation of the participant is encouraged. Social negotiation facilitates the students to construct common interpretations of events and objects. If learners actively build their interpretations of the world, they have more ownership of those thoughts. Further, social negotiation promotes the construction of common interpretations of events and objects (Heathcote, & Herbert, 1985).

Drama based instruction provides students opportunities to take risk in their learning without fear of punishment, to face and deal with human issues and problems, as well as to reflect on the implications of choices and decisions they may have made in the dramatic context (Farris & Parke, 1993).

Knowing each other better and appreciating themselves as human beings is the one of the most important goals of the drama activities (Heinig, 1988; Philbin & Myers, 1991). It allows children to put themselves into other’s shoes. Using personal experience helps students understand others’ points of view. They have the opportunity to see the world from another point of view and to respond as that person would respond. If the perspectives of others can be understood, more tolerant understanding of others and more effective communication will be developed (Heinig, 1988).

The pedagogical benefits of drama are stemmed from the connection between the experiences of the learner and the subject matter (Courtney, 1990).

The creative imagination and dramatic action are experienced together to make meaning of the actual world (Freeman, 2000).

The only communication way for the students in traditional classroom is listening; and students are inactive receiver in those settings. On the other hand, drama itself is an important method of communication. It offers a variety of communication experiences to the students (Heinig, 1988; Southwell, 1999). In drama activities, students are encouraged to express their own ideas and to understand the messages of others by using both nonverbal and verbal communication.

Drama based instruction is in accordance with Howard Gardner's theory of multiple intelligences. Students with different intelligences can experience a wide variety of activities offering them several ways of learning the concept (Gardner, 1985).

2.8 Phases of Drama Based Lesson

Generally drama based lesson consists of three parts; introduction, development, and quieting (Heinig, 1988).

In the introduction part, warm-up activities are used to lead everyone goes in a relaxed mood, ready to work together in a harmony, trust each other and also have fun. As Cottrell (1987; p.87) stated, students need to "shift the gears and recharge their imaginations" at the beginning of the lesson so that they can be ready and confident for the rest of lesson. Warm-up activities also give students some hidden clues about the rest of the lesson (Heinig, 1988).

In the development part, make-believe environment is created in which students are pretending as if something is happening and/or as if be someone. Make-believe atmosphere creates natural place for dramatics moments and require abstraction and imagination. Make believe play brings a metaphor which is a link constructed between the topic of the lesson and the real life. A frame and roles that are associated with students' actual experience and knowledge from daily life examples, conditions and situations are presented to the student to foster meaningful understanding.

Make believe play is "essentially a mental activity where meaning is created by the symbolic use of actions and objects" (Bolton, 1986). Throughout any type of drama activity, there are a number of symbol systems used which help create metaphor. These are “iconic” (the use of symbols; pictures, photos, letters); “enactive” (people making sense of the world by participating in active form) and “symbolic” (knowing through use of language) (Combs, 2001).

In this metaphoric environment, students are posed with dramatic moment in which they faced with the tension of time, an obstacle to overcome, mission to accomplish, or status to be challenged (Neelands, 1991). One of the key concerns of the drama is creating dramatic moment. Dramatic moment, which can also be called conflict or tension, means the struggle between opposing forces (Andersen, 2000). This is a necessary element in dramatic structure, since it gets the attention of the participants and keeps interest until it is resolved. It also provides to create suspense that keeps the students in a state of anticipation over the outcome of the problem (Heinig, 1988). By means of the dramatic moment, students feel the necessity of the solving problem or understanding the situation. In other words, conflicts provide motivation and reasons for the learning.

Dramatic moments force students to remove the obstacle, or accomplish the mission in given time. In order to get rid of these tensions, students have to create some ideas, discuss their ideas with their friends. The pressure and genuineness of the conflict can help children create new knowledge and make different and necessary connections (Booth, 1985). This means that, dramatic moment creates force to the participants to construct new knowledge and find necessary relations.

One or more different drama techniques in education are used to enable to achieve objectives of the lesson. Drama techniques determine the form of the dramatic activity and the way of the students behave. For a particular lesson, they are chosen by considering the appropriateness to the needs and experience of the group, the content, available time and space so that they will be effective (Neelands, 1991).

Lastly, in quieting phase, the key points of the activity are summarized. Students review what they have learned either by answering or solving the questions posed by the teacher, or presenting what they have learned by an improvisation that requires the use of knowledge learned. This phase is important to see whether learning and progress are accomplished or not.

2.9 Drama Techniques

Not all drama techniques can be applied in every topic. If teachers have repertoire of them, they can use a suitable one for a particular topic in a particular grade level. The adoption of a drama technique is the teacher's concern. Drama techniques can take various forms as follows:

Mantle of Expert: Students are given the role of experts in a particular area, and the teacher-in-role asks for their suggestions to solve some conflicts raised in the drama. Students become characters that are specialist and have knowledge and skills about the situation such as mathematicians, social workers, scout leader, director, etc. Generally the situation is task oriented so that the expert understanding and skills are required to perform the task (Heathcote & Herbert, 1985; Neelands, 1991).

Meetings: Students get together to hear news, plan action, make decision together and propose strategies to solve problems that have emerged. The meeting may be run by the teacher-in role or group of students (Neelands, 1991).

Role-Play: Students pretend to be a character by putting themselves in a similar position and imagining what that character might say, think and feel (Neelands, 1991).

Still- Image: In order to make clear and emphasize a moment, an idea, a concept or a theme, students construct an image using their own bodies (Neelands, 1991; Swartz, 2002).

Games: Traditional games or suitable variations of them are used to establish trust, confidence or rules. They are selected to simplify a complex experience; and can be used to put into the context of drama rather than played for their own sake (Neelands, 1991).

Diaries, Letters, Journals and Messages: Diaries, letters, journals and messages are written in or out of role to reflect on experience; to review work; or to build up a cumulative account of a long sequence of work (Neelands, 1991).

Whole Group Role Play: The entire class (teacher as well) behaves, as they were an imagined group facing a situation as it actually happening around them. Language and manners are limited to the condition and the character involved. Therefore communication among the students must be appropriate to the situation (Neelands, 1991).

Telephone Conversation: This occurs as two-way conversation between pairs or one-way conversation where the group only hears one side of the conversation. In order to explain the situation, and inform the person who have missed some information, this technique can be used (Neelands, 1991).

Interviews: Interviews are challenging, and demanding situations designed to reveal information, attitudes, motives, aptitudes and capabilities. Interviewer has the charge of eliciting reaction through suitable questions (Neelands, 1991).

Hot Seating: Students, performing as themselves, have the opportunity to question or interview a role-player who remains in a character. The individual student sits in the "hot seat" and has questions fired at them that they have to answer from the point of view of the role they are enacting. Improvisation may be frozen and role player answers questions (Neelands, 1991; Swartz, 2002).

Overheard Conversation: Students heard a conversation and might not know who the speakers are, or might know one of the speakers. The information gathered from those conversions might be reported by spies, or be in the form of gossip and rumor. These conversations add tension or information to a situation that should not have been heard. The group can go backwards in time to recreate key conversations that illuminate the present situation (Neelands, 1991; Swartz, 2002).

Reportage: This provides an interpretation of events, situations and concepts through a journalist perspective and presents in the form of TV news or documentaries. The students may be in media roles to reveal what has happened from a distance, within emphasis on how events can be interpreted by outsiders (Neelands, 1991).

Noises Off: The conflict and motivation result from a sense of threat or danger, that is coming up but not actually present. Students work with/against an imagined presence. For example they hide from an imagined enemy, or prepare for a significant guest. They are given orders/instructions from an outsider who they never meet face to face (Neelands, 1991).

Teacher-in-Role: The teacher manages the learning opportunities provided by the dramatic context within the context by adopting a suitable role in order to; excite interest, control the action, and invite participation provoke tension, challenge superficial thinking, create choices and ambiguity, develop narrative, and create possibilities for the group to interact in role. The teacher is not acting spontaneously but is trying to mediate her/his teaching purpose through her/his involvement in the drama (Neelands, 1991; Swartz, 2002).

Role-Reversal: Students exchange their roles in some part of the activity. As play-within play, and one group display to each other how they think and behave (Neelands, 1991).

Forum-Theatre: A small group of students is engaged a situation or a concept (chosen by the students to illuminate a topic or experience relevant to the drama) while the others observe. Both the actors and the observers have the right to stop the action whenever they feel it is losing direction, or if they need help. Observers may step in and add a role or take over an existing one (Neelands, 1991; Swartz, 2002).

Analogy: A problem is revealed through working on a similar situation that reflects the real problem. Generally this technique is used where the real problem is too familiar; connections can be made between familiar experience and unfamiliar experience (Neelands, 1991).

Re-enactment: An event that is known, or has previously occurred, is re-enacted in detail to show what might have happened, or in order to find out its details. This may be a whole-group re-enactment, or small-group presentation (Neelands, 1991).

Small-group play making: Small groups plan, arrange and present improvisations as a means of representing an idea, a hypothesis, or show different perspective of action. The improvisations express existing perspective of a condition or experience (Neelands, 1991).

Flashbacks: Events from the past are blended with the presentation of current events. This technique is frequently used in order to illustrate a character’s memories or to explain the outcome of certain actions. To recall what happened in the past, to show the audience, what had happened in the past.

Mimed Activity: Students act without speaking. This activity emphasizes movement, actions and physical responses rather than dialogue or thoughts. Speech can be included as an aid to enactment, encouraging a demonstration or behavior rather than a description of it (Neelands, 1991).

Writing in Role: Students are asked to write a letter, a report, etc. while pretending that they are the character in the story like reporter (Neelands, 1991; Swartz, 2002)

2.10 Researches on Drama

Previous researches revealed that drama has positive effect on language development and communication skills (Ballou, 2000; Çebi, 1985; De La Cruz, 1995; Flennoy, 1992; Gönen & Dalkılıç, 1988; Ömeroğlu, 1990; Öztürk, 1997). Gönen and Dalkılıç (1988) studied on the effects of drama on five – seven years old children language development. They used an experimental design. Peabody picture vocabulary test was administered as a pretest and after completion of 13 weeks of drama activities, this test was administered again. The treatment effect was significant for vocabulary gaining. They concluded that the significant difference in the posttest indicated that experimental group children had acquired more vocabulary than the control group children.

Ömeroğlu (1990) conducted a study on the effects of drama on verbal creativity of 80 five- six year old children. Children's verbal creativity was measured by Torrance Creative Thinking Test. The findings revealed that drama method is effective on verbal creativity of these preschool children. Çebi (1985) studied on the effects of drama on communication and imaginative language skills of high school graduates. As a result of the study, Çebi concluded that drama enhances imaginative language skills. Öztürk's (1997) study was on the effects of the drama on verbal communication skills of preservice teacher. In this pretest posttest control group design, observation form to measure verbal communication skills was the measuring tool. The comparison of pre and post observation notes revealed that drama has positive effects of preservice teachers' verbal communication skills.

Flennoy (1992) studied the effects of drama on communication skills of first grade students. The students were observed in three months and teachers were interviewed. The findings claimed that drama increased the communication skills and made students more willing to study. De La Cruz (1995) investigated the effects of drama on language usage on social and oral expressive and receptive language skills of children with learning disabilities. While the experimental group (n=21) participated in a 12-week drama program, the control group (n=14) did not. The groups were given pre and posttests on the social competence and school adjustment and language development test. Structured interviews were carried out with the experimental group. Results indicated that the difference between the mean gains of the experimental and control groups was significant for social skills and oral expressive language in the favor of experimental group. Interviews demonstrated that the experimental group enjoyed the experience of learning through drama lessons.

Ballou (2000) studied on the effects of drama on communication skills and attitudes toward school and learning of 24 at-risk sixth grade students. Twelve pairs of at risk students were randomly selected to participate in a 20-week, 4.3 hours per week, in-school drama experience. The identified at- risk students were matched, based on an at-risk index, reading level, discipline infractions, age, and attendance patterns. This study lasted 20 weeks; during which time the experimental subjects received 5,000 minutes of scheduled contact. The results of this study indicated that drama had a significantly positive effect on experimental students' communication skills and on their attitudes towards school and learning.

Some researchers studied on the effects of drama on social characteristics like socialization, empathy, self-confidence, self-image, self-actualization, and self awareness (Akın, 1993; Farris & Parke, 1993; Freeman, 2000; Okvuran, 1993; Porteous, 2003; Yassa, 1999).

Akın (1993) studied on the effects of drama based instruction on third graders socialization. She used pretest and posttest control group design. Experimental group was received 10-week drama course. Both groups were administered Moreno sociometry test as pre and posttest. At the end of the ten weeks, there was an increase on the socialization level of the experimental group.

Yassa (1999) studied on high school students' perception of being involved in drama and the effect of this involvement on their social interactions. Purposive sample from two high schools consisted of two male and four female, grade 10- 13 students and three teachers were observed and interviewed. Interviews and non-participant observations were used for data collection. Findings of the study showed that participating drama enhanced social interaction, self-confidence, and improved self-image. Students learned how to control and express their emotions and feelings in acceptable ways, improved their ability to express themselves effectively, developed an appreciation each other and learned to recognize that person had abilities, contributions to make and were more tolerant after drama activities.

Porteous (2003) investigated the value of drama in the development of the awareness of self as perceived by young people aged between 16 and 21. She interviewed with five drama participants from urban settings to get their thoughts. Considering participant responses', she concluded drama was helpful for the young people's understanding of themselves. They stated that they knew when they have done good work.

Farris and Parke (1993) carried out an ethnographic study on five sixth-grade students who participated in a three week session drama workshop to find out what students thought about drama and how it helped them in the classroom. The sample was chosen from nineteen students who were rated as creatively gifted by a panel of art educators. Students and drama instructor interviewed and drama workshop was observed. During the three-week session, students were asked several oral questions related with their participation into drama activities. According to the findings, students suggested that this approach created an atmosphere of acceptance, increased cooperation, self-confidence, self-actualization, and empathy. Student could freely take risks without negative peer pressure.

On the other hand Freeman (2000) and Okvuran (1993) showed contradictory results. Freeman (2000) examined the effects of participation of drama on the self-concept, behavior, and social skills of third and fourth grade children. A sample of 237 subjects, 119 from grade three and 118 from grade four, were randomly selected and assigned to treatment and control groups. Subjects in the treatment group participated in drama activities one day each week, 40 minutes per day for 18 weeks and subjects in the control group participated in regularly scheduled general music classes. The student self-concept scale and the social skills rating system were used as pretest and posttest measures. Results of the data analysis showed that the effects of drama were not significant for self-concept, behavior, or social skills. Even though significant treatment effects were not found, differences in gains were favorable on each of the dependent variables for the treatment group compared to the control group.

Okvuran (1993) investigated the effects of drama on empathy skills and emphatic tendency. The sample of this study consisted of sophomore and junior of preservice teachers. Teacher candidates were received 14-week drama courses and administered empathy scale as a pre and posttest. Analyses of the results showed that there were no significant changes on empathy skills and emphatic tendency.

The earlier studies revealed that drama has positive effects of critical thinking (Fischer, 1989; Wetterstrand, 2002). Fischer (1989) examined the effects of drama exercises on thinking and critical thinking skills. A total of 107 seventh grade students enrolled in junior high language arts were utilized in the study. Both treatment and control groups received instruction in the district's required mythology unit of study for seventh grade. Analysis of the data resulted in significant correlation in thinking and critical thinking. Treatment groups compared to control groups were significantly higher in thinking skill development. Likewise, in development of critical thinking skills the treatment groups compared to control groups were significantly higher.

Wetterstrand (2002) examined to what extent do elementary school students express critical thinking in drama and what are the properties of this thinking? During the investigation the researcher observed a five-grade class for 8 months. All student works in drama and student interviews about the work were documented via a video record and serves as the raw data for the researcher. The study displayed the nature of the critical thinking in which students engage in drama activities. The research offered current conceptions of educational drama and critical thinking as the bases from which to explore children's ability to think critically while engaged in drama based instruction.

2.11 Researches on Drama based Instruction

Researches studied on relation between drama based instruction and learning foreign language (Ay, 1997; Aynal, 1989).

Ay (1997) investigated on drama based instruction on learning foreign language. In this descriptive study, she discussed how drama can be used in teaching foreign language effectively and suggested lesson plans in language learning. Aynal (1989) compared the drama based instruction with lecturing on third graders' learning on English vocabulary and imperative sentences. He revealed that drama based instruction has a significant positive effect on students' achievement.

Studies also showed that drama based instruction has positive effects on standardized proficiency tests (Barnes, 1998a), and reading comprehension skills (Dupont, 1989).

Barnes (1998a) studied on the effects of drama based instruction on third grade social classes on students' standardized proficiency achievement. She described how drama was used in third grade social classroom to help make the social studies curriculum content more meaningful and more accessible to students. Beside the standardized proficiency test the observations and interpretations of students' experiences in drama social study lesson used as the data of the study. She observed that students were making meaningful connections between their lives and the curriculum that they were encountering. They began to understand and use new vocabulary correctly in context.

Dupont (1989) carried out a study to measure the increase in reading comprehension skills of fifth-grade reading students after their exposure to a drama based instruction on children's literature reading. The sample consisted of three groups, each having 17 fifth-grade remedial reading students. He used a pretest- posttest control group design. First group was required participate in dramatic activities that corresponded to the stories. Second group was required to only read and discuss by traditional methods the same children's literature stories as first group. The control group, continued with their usual curriculum during the treatment period. Groups were given the Metropolitan reading comprehension test of the reading diagnostic test as pre and posttest measures. Analysis of variance showed that first group achieved significant mean gain scores, whereas the other two groups mean scores showed no gain as indicated by the pretest and posttest scores. However there were no significant differences between posttest mean scores of the groups.

Prior investigations demonstrated that drama based instruction has positive contributions on science achievement (Kamen, 1992; Kase-Polisini & Spector, 1992; Selvi & Öztürk, 2000; Warner & Andersen, 2002).

Kamen (1992) designed a study to investigate the effectiveness of drama based instruction including the use of movement, pantomime, improvisation, role-playing and characterization, in enhancing student understanding of science concepts. The study was carried out in two elementary classrooms in which drama based instruction is used as part of science instruction. Written tests for the students; interviews with students and teachers; and direct observations were the four measuring tools of the study. The results indicated that the students' achievement improved on the content tests. Both the students and the teachers reported benefits from drama, including a better understanding of the concepts and an improved motivation and interest in learning science. The students enjoyed the use of drama based instruction and felt they learned more when this method was included.

Selvi and Öztürk (2000) studied the effects of drama based instruction on fifth grade student's achievement on “body recognition” and attitude toward science compared to traditional teaching. The treatment lasted four weeks totally 24 lesson hours. The results revealed that experimental group was significantly better on achievement test, but there were no difference between groups on science attitude score.

Warner and Andersen (2002) carried out a study on a class of preservice teachers who were enrolled in a science and language arts method course and two second-grade classes. One of the second grade classes experienced the drama based instruction on science inquiry lesson; the other was the control group. The participants were separated into groups of three, each consisting of two preservice teachers and one second grader. In the drama based instruction the second graders were given the role of zoologist who had to decide how to care for snails at the zoo and they were asked advice about snails as an expert in the field. In the control group, the same preservice teachers and a different group of second graders engaged in the same science inquiry, but without the zoologist role of the second graders. The results revealed that the experimental group student showed deep levels of learning engagement. They generated their own questions in the role of expert scientist and then moved beyond role-playing to think and question as expert scientists. In the control group, the second graders were able to engage in the inquiry lesson successfully but had to be assisted to a greater extent to further the inquiry. Engagement in the lesson did not occur quickly. While the experimental group ended up with numerous pages of notes, the notes in the control group were only one or two pages long.

Kase-Polisini and Spector (1992) described a quantitative study in which high achieving science and mathematics students studied science concepts through drama based instruction. For eight consecutive summers a group of students attended a two-week program that was designed by a theater education professor and a science educator professor. Participants were instructed to produce a play to dramatize the specific math and science concepts they were taught during the two-week experience. The researchers found drama based instruction to be an effective strategy for teaching science.

The effects of drama based instruction on students' achievement and attitudes were examined in teaching Basic Rights and Duties in Liberal Democracy unit of eight grade in a PhD study (Üstündağ, 1997). This study was carried on 58 eight-grade students (30 were in experimental group and 28 were in control group). Experimental group were taught the Basic Rights and Duties in Liberal Democracy unit with drama based instruction. On the other hand control group students were taught by traditional approach. According to the findings a significant difference was found between the means of achievement scores of experimental group and the control group. For the attitude score there was a significant difference between the groups, as well. As a conclusion this research, the researcher claimed that using drama based instruction on Basic Rights and Duties in Liberal Democracy unit has a positive effect on 8^{th} grade students' attitude the content area and achievement.

Koç (1999) investigated the effects of drama based instruction on fourth grade students' social sciences achievement compared to traditional teaching. Experimental group was taught the topic of "Turkish movement to Anatolia" by drama based instruction; the control group received traditional teaching. Results revealed that experimental group got significantly better scores on achievement tests related with the topic taught.

2.12 Researches on Drama Based Instruction in Mathematics Education

There are very few studies focused on the use of drama based instruction on mathematics education. A lack of qualified researchers (certified both mathematics education and drama) in the field can be a reason of this. Beside this, a resistance of principals and teachers to a new approach brings the lack of the research on drama based mathematics education. Another reason may be the deficiency of consensus on how should be a drama based instruction. Different researchers have different perspectives. The most important reason may be the fear of the idea that drama is not an appropriate teaching method in mathematics education.

On the other hand it can be said that using drama based instruction is fitting the mathematics education. As Bruner (1966) stated play is directed towards abstraction. Creating an imaginary situation can be regarded as a means of developing abstract thought. Since making abstracting is one of the most important asset in mathematics education, one can say that drama based instruction is very suitable in mathematics teaching.

Saab (1987) examined the effects of drama based mathematics instruction on 87 sixth graders compared to textbook-oriented mathematics instruction. In this pretest posttest experimental study, groups difference were analyzed using student scores of mathematics achievement, attitudes toward mathematics, and creativity. Once the pretests for the three dependent variables were given, the experimental groups received eight weeks of Drama/Mathematics activities during their regular mathematics classes. The control groups received textbook-oriented mathematics instruction without any of the Drama methods integrated into their classes. All students were then posttested with the mathematics achievement test; mathematics attitude scale; and a creativity test. The pretest and posttest scores were analyzed by means of analysis of covariance. The results showed that drama based activities caused a significant increase in levels of mathematics achievement related mathematics computation. Attitudes toward mathematics and levels of creativity were not affected by the use of drama based activities.

Omniewski (1999) studied on the effects of an arts infusion approach on the mathematics achievement of 49 second-grade students. Her aim was to determine whether a significant difference existed in mathematics achievement scores among an experimental group using an arts infusion approach (n=16), a group using an innovative manipulative approach (n=16), or a group using a traditional textbook approach (n=17). The first group was taught with an arts infusion approach in which music, art, dance, and drama were used. The second group was taught with an innovative manipulative approach in which tactile or hands-on methodology was used. The control group was taught using a traditional textbook approach. Groups were taught the mathematics concepts of patterning, sorting, classifying, and graphing by the same teacher for daily periods of 45 minutes for six weeks. All three groups were pre- and posttested using the textbook unit math test and the number patterns test. Six weeks after the treatment, subjects were administered a delayed posttest to examine retention among the groups. Results showed that all three groups' scores showed significant textbook unit math test regardless of instructional method. However art infusion group surpassed the other two groups in gain scores on he textbook unit math test. The biggest increase in the art infusion group's the textbook unit math test scores occurred between posttest-1 and posttest-2, indicating a more significant gain score difference in retention than among the other two groups. As a result of this study, she claimed that use of an arts infusion approach was found to be as effective as innovative manipulative or traditional textbook approaches in teaching mathematics, and a significant gain in retention of mathematics concepts occurred through the use of arts infusion.

Southwell (1999), on the other hand, gave only examples of using dramatic moments to explore mathematical ideas, to challenge students and to develop conceptual understanding at the beginning, at the middle or at the end of the lesson.

2.13 Summary on Effects of Drama

When the literature on the effects of drama on the cognitive domain is investigated, it is seen that drama based instruction

- develops critical thinking skills (Bailin, 1998; De La Roche, 1993; Kelner, 1993; San, 1996),
- supports reflective thinking (Andersen, 2002; Neelands, 1984),

- stimulates the imagination and promotes creative thinking (Annarella, 1992; Bolton, 1988; Freeman, 2000; Heinig, 1988; Kelner, 1993; Morris, 2001; San, 1996),
- promotes language developments (Farris & Parke 1993; Heinig, 1988; Kelner, 1993; Wagner 1985),
- promotes problem-solving skills (Bolton, 1985; De La Roche, 1993; Freeman, 2000; Heinig, 1988),
- fosters decision making skills (De La Roche, 1993; San, 1996),
- strengthens comprehension and retention (Annarella, 1992; Kelner, 1993; Omniewski, 1999; Southwell, 1999),
- promotes ability to work cooperatively (Farris & Parke 1993, Kelner, 1993, Wagner 1985),
- fosters think metacognitively (Andersen, 2002),
- improves achievement in different content areas (Aynal, 1989; Barnes, 1998b; Dupont, 1989; Farris & Parke, 1993; Kamen, 1992; Kase-Polisini & Spector, 1992; Koç, 1999; Omniewski, 1999; Saab, 1987; Selvi & Öztürk, 2000; Üstündağ, 1997),
- promotes language developments (Çebi, 1985; Gönen & Dalkılıç, 1988; Heinig, 1988; Kelner, 1993, Ömeroğlu, 1990; Öztürk, 1997), and
- promotes communication skills (Ballou, 2000; Bolton, 1985; De La Cruz, 1995; Flennoy, 1992; Kelner, 1993; Southwell, 1997; Yassa, 1997).

Advantages of using drama on effective domain can be summarized as follows; it

- provides sensory awareness (Bolton, 1998; Heinig, 1988),
- enhances the pupils' self-esteem (Bolton, 1985; Yassa 1997),
- improve self confidence (Bolton, 1985; Drege, 2000; Farris & Parke 1993; Freeman, 2003; Porteous, 2003; Yaffe, 1989; Yassa 1997),
- increases empathy and awareness of others (Annarella, 1992; Farris & Parke, 1993; Heinig, 1988; Kelner, 1993; Wagner 1985; Yassa, 1999),
- reinforces positive self-concept (Farris & Parke, 1993; Kelner, 1993; Wagner 1985), and
- enhances emotional control (Courtney, 1990; Freeman, 2000).

CHAPTER 3

METHODS

This chapter explains population and sample, measuring tools, variables, procedure, teaching/learning materials, treatment, treatment verification, methods for analyzing data and internal validity of the study.

3.1 Population and Sample

The target population consists of all seventh grade public primary school students in Ankara. The accessible population is all seventh grade public primary school students in Balgat district, Ankara. This is the population from which the results of the study will be generalized.

There are 13 public primary schools having 32 seventh grade classes in Balgat district. Total number of seventh graders in public primary schools in Balgat district is about 1000. The school names, the number of seventh grade classrooms, and class sizes are given in Table 3.1.

Table 3.1 Seventh grade classroom distributions with respect to public primary schools in Balgat district

School names	Number of seventh grade classrooms	Class size	Total number of seventh graders
Ahmet Barındırır İÖO	3	~34	~102
Ülkü Akın İÖO	3	~35	~105
Türk-İş İÖO	2	~30	~60
Milli Egemenlik İÖO	1	~30	~30
Ahmet Bahadır İÖO	2	~28	~56
Arjantin İÖO	2	~40	~80
Hasan Özbay İÖO	2	~20	~40
Yasemin Karakaya İÖO	3	~30	~90
Balgat İÖO	2	~35	~70
Mustafa Kemal İÖO	3	~30	~90
Akpınar İÖO	2	~30	~60
Kılıç Ali Paşa İÖO	3	~35	~115
Talatpaşa İÖO	4	~28	~112
Total number	32		~1000

Since it was difficult to select a random sample of individuals, convenience sampling was used in this study. The sample was the seventh grade students in a public primary school in Balgat district of Ankara. There were three seventh grade classes taught by two different mathematics teachers in this school. Two classes constituted the experimental group (EG) and the other class constituted the control group (CG). The groups were assigned as the experimental and control group according to the time schedule of their mathematics lessons. Two of the three classes had two hours of mathematics lessons at the same time. As the researcher taught the courses in the EG, one of these two classes having coinciding mathematics lesson was assigned randomly as the CG. The remaining two classes were assigned as the EG. There were 34 students in each class, hence the experimental group had 68 and the control group had 34 students. The sample size of 102 students constituted at least 10 % of the population. The distribution of the subjects in the experimental and control groups in terms of gender is given in Table 3.2.

Table 3.2 The distributions of the subjects in the EG and the CG in terms of gender

	Groups		
	EG (%)	CG (%)	total
Female	40 (58.8)	22 (64.7)	62 (60.8)
Male	28 (41.2)	12 (35.3)	40 (39.2)
Total	68 (100)	34 (100)	102 (100)

3.2 Measuring Tools

In order to gather data, five instruments were used in the study; two achievement tests (one on angles and polygons, and the other on circle and cylinder), van Hiele Geometric thinking level test, mathematics attitude scale, and geometry attitude scale.

3.2.1 Angles and Polygons Achievement Test

Angles and Polygons Achievement Test (APA) was developed to investigate the students' achievement on angles and polygons (see Appendix A). This test consists of 17 open-ended questions, most of which have subtasks. Each task together with its objectives is presented in Appendix B. In addition to these subtasks, explanations required for some questions were also taken as different tasks. Totally, this test includes 326 tasks, 72 of which were related with angles and 254 of which were on polygons. Among the tasks related with angles, there were tasks on adjacent, vertical, corresponding, congruent, interior, and exterior alternate angles. The tasks on polygons were about identifying polygons namely triangle, square, rectangle, diamond, parallelogram, trapezoid, and rhombus; and the perimeter and area of polygons. Each task was assessed by giving one for each correct answer and zero for each incorrect answer. Therefore, possible maximum score for the APA was 326.

3.2.2 Achievement Test on Circle and Cylinder

In order to determine students' achievement on circle and cylinder, Circle and Cylinder Achievement Test (CCA) was developed (see Appendix C). It involves 15 open-ended questions containing subtasks. Each task together with its objectives is provided in Appendix D. Explanations required for some questions were also taken as different tasks. This test contains 42 tasks, 36 of which were on circle and six were on cylinder. The tasks on circle were specifically on the concept of circle, radius, diameter, position of a line and circle with respect to each other (tangent, chord); arcs and angles of circle (inscribed, central angle); perimeter and area of a circle. The tasks on cylinder were particularly on the drawing and explanations of open form of cylinder, and area and volume of a cylinder. Each task in this test was assessed by giving one for each correct answer and zero for each incorrect answer. Therefore, possible maximum score for the CCA was 42.

3.2.3 Van Hiele Geometric Thinking Level Test

In order to determine students' geometric thinking levels, the van Hiele Geometric Thinking Level Test (VHL) including 25-multiple choice questions developed by Usiskin (1982) was used (see Appendix E). In this test, the first five items represent level 1, second five items represent level 2, the third five items represent level 3, the fourth five items represent level 4, and the last five items represent level 5. Since the primary school mathematics leads students only reach to the third level (van Hiele, 1986), merely the first 15 questions were considered in the study. The questions in the first level are related to identifying triangle, rectangle, square, and parallelogram. The questions in the second level are about the properties of square, rectangle, diamond, rhombus, isosceles triangles, and radius and tangent of circle. The questions in the third level are on ordering properties of triangle, simple deduction, comprehending hierarchy among square, rectangle and parallelogram, and comparing rectangle and parallelogram. The objective of each questions of the VHL is presented in Appendix F. Each question in the VHL was assessed by giving one for each correct answer and zero for each incorrect answer. Thus, the possible scores of the VHL range from 0 to 15.

This test was translated into Turkish during a master thesis study (Duatepe, 2000a). In this study, Cronbach Alpha reliability measures were found as .82, .51, and .70, for the first, second, and third level, respectively.

3.2.4 Mathematics Attitude Scale

The Mathematics Attitude Scale (MAS) developed by Aşkar (1986) was used in order to determine students' attitudes toward mathematics (see Appendix G). It consists of 20 Likert type items with five possible alternatives as strongly disagree, disagree, uncertain, agree, and strongly agree. Negative statements were scored as 5, 4, 3, 2, and 1 and positive statements were scored as 1, 2, 3, 4 and 5 according to the order of alternatives. Aşkar (1986) reported Cronbach alpha reliability coefficient of the scale as .96. The possible scores on this scale range from 20 to 100.

3.2.5 Geometry Attitude Scale

The Geometry Attitude Scale (GAS) was developed to determine students' attitudes toward geometry (see Appendix H). This test was two-dimensional having 12 items. Seven items (item number 1, 2, 6, 7, 9, 10, and 11) represent interest and enjoyment dimension and five items (item number 3, 4, 5, 8, and 12) represent confidence and anxiety dimension. Students were asked to rate statements by marking a five-point Likert scale with the alternatives of strongly disagree, disagree, uncertain, agree, and strongly agree. Negative statements were scored as 5, 4, 3, 2, and 1 and positive statements were scored 1, 2, 3, 4, and 5 in the order of alternatives. The possible scores of the GAS range from 12 to 60.

3.3 Variables

Seven dependent and five independent variables were considered in this study.

3.3.1 Dependent Variables

Dependent variables of the study are; students' posttest scores on angles and polygons achievement test (POSTAPA), on circle and cylinder achievement test (POSTCCA), on van Hiele geometric thinking level test (POSTVHL), on mathematics attitude scale (POSTMAS), and on geometry attitude scale (POSTGAS); students' delayed posttest scores on angles and polygons achievement test (DELAPA) and on circle and cylinder achievement test (DELCCA).

3.3.2 Independent Variables

Independent variables of the study are; methods of teaching (MOT), students' gender, mathematics grade in previous year (MGP), students' pretest scores on van Hiele geometric thinking level test (PREVHL), on mathematics attitude scale (PREMAS), and on geometry attitude scale (PREGAS).

3.4 Procedure

The aims of this study were to investigate the effects of drama based instruction on seventh grade students' achievement on geometry (angles and polygons; circle and cylinder), retention of achievement, van Hiele geometric thinking level, attitudes toward mathematics and geometry compared to the traditional teaching; to get the students' views related to the effects of drama based instruction on their learning, friendship relations, awareness of themselves, and the role of teacher and students; and to get the views of teacher who was present on drama based instruction. The study was conducted in mathematics courses designed to teach the regular topics of seventh grade geometry, involving angles, polygons, circle, and cylinder. This is a quasi-experimental study, in which two different learning environments, drama based instruction and traditional teaching, were compared. While the EG learned geometry with drama based instruction, the CG learned it with traditional teaching. To familiarize the EG students with the researcher, the researcher was present in the EG classrooms for two weeks prior to study.

The treatment in drama based environment included experiencing or living an idea, a concept, or unit by expressing, explaining, discussing, criticizing, and justifying ideas by taking roles in drama activities. This is an exploratory and experiential approach to learning in which students are learning by living and doing while pretending as something is happening and/or as someone. The lessons in this environment were conducted by using the lesson plans developed by considering criteria of drama based instruction. These lesson plans were piloted on sixth, seventh, or eighth grade students from a school other than the one used in the main study during the first semester of 2002-2003 academic year. The purpose of piloting lesson plans is to test their appropriateness for the specified topics, applicability in classroom settings, and attractiveness to the students. More details about this piloting are given in Section 3.5.

The traditional instruction environment, on the other hand, was based on a textbook approach using chapters related to the angles, polygons, circle and cylinder from *İlköğretim Matematik 7* (Yıldırım, 2001), the adoptive text-book for the seventh grade students.

The two achievement tests used in this study, the APA and the CCA were developed and piloted before the study. Details related to the development of these instruments can be seen in Chapter 4. The final form of these tests were administered as post and delayed posttest to both the EG and the CG. The time allotted for the APA was one and half lesson hour without taking a break in succeeding two lessons, for the CCA was one lesson hour. Prior to administering the achievement tests, the researcher announced the students that their scores from these tests would affect their course grade to make them answer questions with diligence, dedicate the duration to the tests and show serious effort in responding each question. The APA was administered as a posttest upon the completion of the treatment on angles and polygons to determine the effects of the drama based instruction on students' achievement on angles and polygons. The CCA was administered as a posttest to the students upon the completion of the treatment on circle and cylinder to determine the effects of the drama based instruction on students' achievement on circle and cylinder. The APA and the CCA were administered as delayed posttests four months after the termination of treatment period, without students' prior knowledge; to investigate the effect of drama based instruction on students' retention of achievement. Both the administration of the APA as post and delayed post yielded Cronbach alpha reliability coefficient of .98, whereas the administration of the CCA as post and delayed post yielded Cronbach alpha reliability coefficients of .95 and .97, respectively, which indicate high reliability.

The geometry attitude scale used in this study was constructed prior to the treatment. Further details of the piloting are included in Chapter 4. The time allotted for the administration of this scale was approximately 15 minutes each time. The GAS was administered as a pretest before the treatment to control differences between groups statistically on their prior attitudes toward geometry. It was administered as a posttest upon the completion of the treatment on geometry to determine the effect of drama based instruction on students' attitude toward geometry. The pre and post administration of the GAS yielded Cronbach alpha reliability coefficients of .92 and .95, respectively, which indicate high reliability.

In order to determine students' geometric thinking levels, the van Hiele geometric thinking level test was administered to both groups as pretest and posttest allowing approximately one lesson hour each time. Pretest was given to control differences between groups statistically on their prior geometric thinking level and posttest was administered upon the completion of the treatment on geometry to determine the effect of drama based instruction on students' geometric thinking level. For this study Cronbach alpha reliability coefficients of the pre and post administration of the VHL were calculated as .43 and .60, which indicate low and moderate reliability, respectively.

Mathematics attitude scale was used to determine students' attitudes toward mathematics. This measuring tool was administered to both groups as pretest and posttest, allowing approximately 15 minutes each time. Pretest was given to control differences between groups statistically on their prior attitude toward mathematics and posttest was administered upon the completion of the treatment on geometry to determine the effect of drama based instruction on students' attitude toward mathematics. In this study, Cronbach alpha reliability coefficients of the pre and post implementation of the MAS were found as .95 and .96, respectively, which indicate high reliability.

The students in both groups were taught the same mathematical content at the same pace in the second term of the 2002-2003 academic year. Treatment period lasted 25 lesson hours. There were four mathematics classes in each week, two of which were at the same day. Each lesson lasted 40 minutes. To be able to use drama based instruction effectively and efficiently in the classroom, it requires necessary training like a master degree on drama, or at least drama training given by associations like Contemporary Drama Association (Okvuran, 2001). Since the researcher attended 168 hours drama courses given by Contemporary Drama Association, she had the necessary qualification. On the other hand, the classroom teacher did not have this training. Moreover, the minimum course of 52 hours lasts 14 weeks, which is quite long time to train the classroom teacher to instruct drama based lessons. For these reasons, the EG was instructed by the researcher with the presence of classroom teacher to control the flow of the lesson in terms of the objectives covered and the researcher bias. The CG, however, was instructed by the classroom teacher. The researcher was also present in the CG classroom two lesson hours a week which were not coinciding the EG mathematics lessons. The teaching in both groups was conducted in their regular classrooms.

Follow up interviews were conducted with 13 students from the EG to get their views related to the effects of drama based instruction on their learning, on their friendship relations, on their awareness of themselves, and the role of teacher and students in drama based instruction environment. Furthermore, to get the views of the teacher on drama based instruction, an interview was carried out with the classroom teacher who was present in the EG during the study. The students were selected by taking into consideration; degree of participation to the drama activities, gender, their post geometry attitude score and their total achievement scores computed by adding their achievement scores from both the post implementation of the APA and the CCA, to have the best representative sample. The degrees of participation were scored by the researcher and the classroom teacher according to their consensus about students' participation levels in the activities. Students were graded between one and five reflecting the degree of their participation to the activities in terms of demonstrating enjoyment in being involved in activities, working well in group works, interpreting and analyzing the work of others, contributing to the discussions and criticizing the ideas willingly. The characteristics of the interview subjects in terms of gender, quartiles of geometry attitude score and total achievement test score and the degree of participation appear in Table 3.3. For the confidentiality, students are referred by numbers instead of their real names.

Table 3.3 The distribution of interviewees in terms of the degree of participation, gender, quartiles of geometry attitude score and total achievement test score

Student	The degree of participation	Gender	Quartile of POSTGAS	Quartile of TOTALACH
S1	5	M	4th	3rd
S2	5	F	3rd	4th
S3	4	F	4th	3rd
S4	4	M	4th	4th
S5	4	F	1st	4th
S6	3	M	4th	3rd
S7	3	F	3rd	4th
S8	3	F	2nd	4th
S9	2	M	2nd	4th
S10	2	F	4th	4th
S11	1	M	2nd	3rd
S12	1	F	1st	2nd
S13	1	M	2nd	1st

Each interview was conducted individually in a quiet area of the school like the library or an empty classroom and audio-taped. In order to increase the probability of honest responses, the interviewees were informed that their names and other personal information would be kept confidential and would not be used in the research report. Although there was no time limitation in the interviews, each individual interview lasted approximately 25 - 35 minutes. Although interviews were primarily structured, some flexibility was provided by reacting spontaneously to student's explanations to make them clearer.

The interviewed students were posed the following questions:

Does drama affect your learning? How?

Are there any negative effects of drama on your learning?

Do you think, what was done during these units have affected friendship relations in class? If yes, in what way? (Think about your relation with your friends or relation between others based on your observations).

During these lessons, have you learned something new about yourself? Do you realize any feature of yourself, you have never recognized before?

Do you think, in these lessons have the role of the students changed? Can you compare the role of the students in these lessons with the role of the students in the other lessons?

Do you think, in these lessons have the role of teacher changed? Can you compare the role of the teacher in these lessons with the role of the teachers in the other lessons?

The classroom teacher was asked the following questions in the interview:

What are the positive aspects of drama based instruction?

What are the negative aspects of drama based instruction?

What are your suggestions about the drama based instruction?

To sum up, the outline of the main study can be seen from Table 3.4.

Table 3.4 Outline of the procedure of the main study

	Experimental Group	Control Group	Time Schedule
Pretests	Van Hiele Geometric Thinking Level Test Mathematics Attitude Scale Geometry Attitude Scale		31 March 2003 31 March 2003 31 March 2003
Treatment	Drama Based Instruction on the Angles and Polygons (by the researcher)	Traditional Teaching on the Angles and Polygons (by the teacher)	2 April – 1 May 2003
Posttest	Angles and Polygons Achievement Test		5 May 2003
Treatment	Drama Based Instruction on the Circle and Cylinder (by the researcher)	Traditional Teaching on the Circle and Cylinder (by the teacher)	6 May – 26 May 2003
Posttests	Van Hiele Geometric Thinking Level Test Mathematics Attitude Scale Geometry Attitude Scale Circle and Cylinder Achievement Test		27 May 2003 27 May 2003 27 May 2003 28 May 2003
	Interviews		29 May – 13 June 2003
Delayed Posttests	Angles and Polygons Achievement Test Circle and Cylinder Achievement Test		20 Sept. 2003 21 Sept. 2003

3.5 Development of the Lesson Plans Used in the Experimental Group

In developing the lesson plans, the objectives of the seventh grade geometry suggested by National Education Ministry (MEB, 2000) were considered to be able to cover each objective and behavioral objectives. So, the same content for both the EG and the CG was provided.

In order to develop drama based lesson plans, a list of criteria for drama based instruction was developed after reviewing the literature (Adıgüzel, 1994; Andersen, 2000; Cotrell, 1987; Güneysu, 1991; Heinig, 1988; Morgan & Saxton, 1987; Neelands, 1991; Nixon, 1988; San, 1996; Tarlington, 1985; Taylor, 2000; Üstündağ, 1994; Üstündağ, 1997; Wilhelm, 1998). The criteria list and the explanations of each criterion were as follows:

Social Metaphor: It is the links created between the topic of the lesson and the real life to make abstract information more concrete and understandable to the students. A frame and roles are associated with students' actual experience and knowledge from daily life examples, conditions, and situations to foster meaningful understanding.

Make-Believe Play: Doing as if something has happened / is happening and pretending as if someone. Make-believe play creates natural atmosphere for dramatic moments and requires abstraction and imagination.

Group work: Drama is generally a shared process. Students have opportunity in drama activities to engage in important social and educational interaction by working collaboratively for a common goal. Working collaboratively for a common goal enables to increase communication and motivation.

The students' role: Students are active participants by doing, expressing, explaining, justifying, drawing, measuring, comparing, finding, deciding, discussing, criticizing, imagining etc. in the make believe play.

The teacher's role: Teachers' role as a guider is to facilitate exploration, development, expressing and communication of ideas, concept and feelings. Teacher should encourage students to express, discuss, criticize ideas by accepting each other's ideas, behaviors, feelings, and even mistakes. By asking questions to the students, forwarding student questions to class and giving necessary feedbacks, teacher enables effective communication. Teacher can participate into the activities together with students. This creates effective teaching relationship between the teacher and students, and enables teacher to control and give direction to what is going on.

Warm-up activities: Drama based instruction generally begins with warm-up activities. As Cottrell (1987; p. 87) stated, students need to "shift the gears and recharge their imaginations" at the beginning of the lesson so that they can be ready and confident for the rest of the lesson. To put them in these moods, ice-breaking activities are used as warm-up activities.

Drama techniques: Drama techniques determine the form of the dramatic activity and how participants behave at particular stages of its development. Some of the drama techniques are still images, holding a meeting, TV program, writing in role, teacher in role, flashbacks, telephone conversation, letters and mantle of expert. For a particular lesson, considering the appropriateness to the needs and experience of the group, the content, available time and space they are chosen.

Dramatic moments: They are tensions created to get the attention of the students, to create interest about what happens next, to make the students feel responsible about learning, and to generate ownership about the situation. Possible dramatic moments mentioned by Neelands (1991) are tension of secrecy, mystery, an obstacle to overcome, time, personal challenge, test, dependence on another, and status to be challenged.

Quieting activities: Either at the end of the lesson or in some part during the lesson, what has happened throughout the lesson was discussed and assessed by solving questions, summarizing concepts or repeating crucial parts. These activities are important to see whether learning and progress are accomplished or not.

Seventeen lesson plans, ten were on angles and polygons and seven were on circle and cylinder, were developed by considering the above criteria. A mathematics teacher in an elementary school and three instructors in universities two of whom were certified on drama and one specialized on mathematics education reviewed the lesson plans developed. These specialists on drama checked the lesson plans to determine whether they are appropriate as a drama based instruction. With their criticism and suggestions, the following modifications were made;

- Additional drama techniques were added. For example, flashbacks in lesson plan 12 were added. In that lesson, different positions of a line and circle with respect to each other were improvised as still image at first. Then each different position of a line and a circle were discussed. A drama technique of flashback was very appropriate to recall the different positions of a line and a circle.
- Warm-up activities were revised to make them more relevant to the objectives of the lesson. For example, in lesson plan 16, following of a rolling barrel with eyes was added to make the students imagine the movement of a cylinder by considering its properties.
- More social metaphors were added. For example, a model of scissors was included in lesson plan 1. By this way, an analogy between the vertical angles and shape of scissors was provided.

The mathematics educator and the mathematics teacher examined the lesson plans to determine whether they were mathematically correct and appropriate for achieving the objectives. With their comments and recommendations, the followings were done;

- All lesson plans were checked to examine the consistency of the objectives and contents.
- Directions in some lessons were modified to make them clear and mathematically correct.

Furthermore, each lesson plans were piloted on six, seven or eight grade classes in a state elementary school other than the one used in the main study. This pilot study was conducted to check whether the lesson plans could be applied in classroom settings, how the classroom settings should be arranged, whether directions given were clear, how the classroom management could be accomplished, and whether the objectives could be achieved. The pilot study also provided the researcher to gain experience about the lesson plans and how to use them in the classroom effectively. During the implementation of these lesson plans, the classroom teachers were present in the classrooms. At the end of each lesson, teachers gave some advices and suggested some modifications related to the flow of the lesson. The following conclusions and suggestions were taken in the consideration in order to revise the lesson plans after the pilot study;

- Some breaks were recommended either at the end of the development or quieting part to give students a chance to take notes.
- In some lessons clues were needed in order to help the students to deal with the dramatic moments. For example, the students were given the dramatic moment related to finding the password to get off the Pentagon building. The password of the building was the sum of the interior angles of the Pentagon. When the students were not able to give the correct answer, they were given a clue such as “consider how many triangles can be drawn in that Pentagon”, “Is the sum of interior angles of a triangle helpful in this situation?” etc.
- Teacher needed to take roles in order to control the students. For example, in lesson plan 11, the teacher took the role of scout leader. But in the piloting of the lesson plan the teacher had not taken any role.

Upon the completion of piloting lesson plans, they were ready to be used (see Appendix I). The objectives of each lesson plan together with their evaluations according to the drama based instruction criteria are shown in Appendix J.

3.6 Treatment

While the EG learned geometry topics with drama based instruction, the CG learned them with traditional teaching as usual, in the treatment phase. General comparison of the EG and the CG in terms of physical environments, teacher's and students' role, student interaction, and homework assignment is given in Table 3.5.

Table 3.5 The comparison of the EG and the CG environment

Category	Experimental Group	Control Group
Physical Environment	The desks were arranged to create an empty space in the center of the classroom and to provide effective communication in groups.	Regular classroom environment
Teacher's role	Facilitator: helping students to explore, develop, express, discuss, and criticize ideas Active participant: taking roles to foster communication and control the students easily	Information giver, presenter
Students' role	Active participants: taking roles; imagining; communicating; exploring; deciding, measuring; calculating; criticizing, discussing, justifying, and expressing ideas	Passive receivers, note taker, listener
Students interaction	Students generally work in groups	Students work alone
Homework assignment	İlköğretim Matematik 7 (Yıldırım, 2001)	İlköğretim Matematik 7 (Yıldırım, 2001)

The sequence of the treatment including topics covered and administration of the tests in the EG and the CG is presented in Table 3.6. As seen from this table, angles and polygons lasted 14 lesson hours and circle and cylinder lasted 11 lesson hours in both the EG and the CG.

Table 3.6 The comparison of the EG and the CG in terms of topics covered, their orders and administration of the tests

Lesson	EG	CG
1	VHL pretest	
2	GAS and MAS pretest	
3	Congruent Angles (Lesson Plan 1)	Congruent Angles
4	Congruent Angles (Lesson Plan 2)	Congruent Angles
5	Medians, altitude and angles bisector of triangles (Lesson Plan 3)	Medians, altitude and angles bisector of triangles

Table 3.6 (continued)

6	Triangular inequalities (Lesson Plan 4)	Triangular inequalities
7	Angles of Triangles (Lesson Plan 5)	Angles of Triangles
8	Polygons (Lesson Plan 6)	Homework questions from textbook related to congruent angles and triangles
9	Angles of Polygons (Lesson Plan 7)	Polygons Angles of Polygons
10	Angles of Polygons (Lesson Plan 7) Homework questions from textbook related to congruent angles and triangles	Properties of Quadrilaterals
11	Properties of Quadrilaterals (Lesson Plan 8)	Rectangle, its perimeter and area Questions related to quadrilaterals
12	Properties of Quadrilaterals (Lesson Plan 8)	Questions related to quadrilaterals
13	Perimeter of Special Quadrilaterals (rectangle, parallelogram, square, diamond, deltoid, trapezoid) (Lesson Plan 9)	Perimeter and area of parallelogram Perimeter and area of a square,
14	Area of Special Quadrilaterals (rectangle, parallelogram, square, diamond, deltoid, trapezoid) (Lesson Plan 10)	Perimeter and area of diamond Perimeter and area of deltoid
15	Area of Special Quadrilaterals (rectangle, parallelogram, square, diamond, deltoid, trapezoid) (Lesson Plan 10)	Perimeter and area of trapezoid Questions related with area and perimeter of quadrilaterals
16	Homework questions from textbook related to area and perimeter of quadrilaterals	Questions from textbook related to area and perimeter of quadrilaterals
17 18	APA as a posttest	
19	Ring and Circle (Lesson Plan 11)	Ring and Circle
20	Ring and Circle (Lesson Plan 11)	Position of a line and circle with respect to each other
21	Position of a line and circle with respect to each other (Lesson Plan 12)	Position of a line and circle with respect to each other, Tangent of a circle
22	Position of a line and circle with respect to each other (Lesson Plan 12)	Arcs and angles of circle
23	Arcs and angles of circle (Lesson Plan 13)	Arcs and angles of circle
24	Tangent of a circle (Lesson Plan 14)	Perimeter of a circle Area of a circle
25	Perimeter of a circle (Lesson Plan 15)	Area of a circle
26	Area of a circle (Lesson Plan 15)	Questions related to perimeter and area of a circle
27	Properties of Right Cylinder (Lesson Plan 16)	Properties of Right Cylinder Area and volume of a cylinder

Table 3.6 (continued)

28	Area and volume of a cylinder (Lesson Plan 17)	Questions related to area and volume of a cylinder
29	Homework questions from textbook related to circle and cylinder	Questions from textbook related to circle and cylinder
30	CCA as a posttest	

3.6.1 Treatment in the Experimental Group

The regular classroom organization given in Figure 3.1 was arranged mostly as in Figure 3.2 and Figure 3.3 at the beginning of the lessons or in the recess between two lessons.

When lesson plans 3, 4, 16, and 17 were carried out, the arrangement of the desks were not changed and the arrangement of the classroom was as in Figure 3.1.

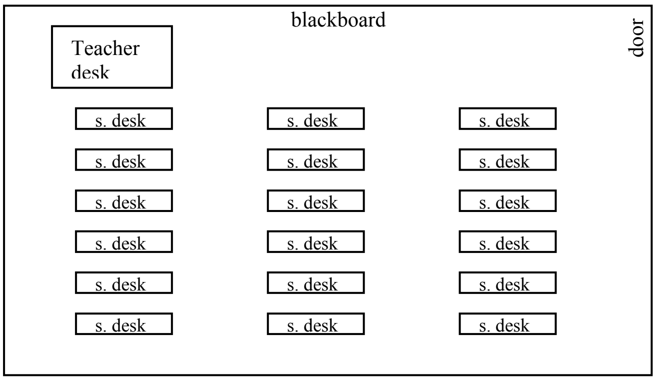

Figure 3.1 The arrangement of the classroom in regular lessons

The lessons preceded with the lesson plans 1, 2, 5, 6, 7, 10, 11, 12, 13, 14, and 15, the arrangement of the desks was changed as in Figure 3.2. This arrangement was done in order to provide an empty space to enable the activities.

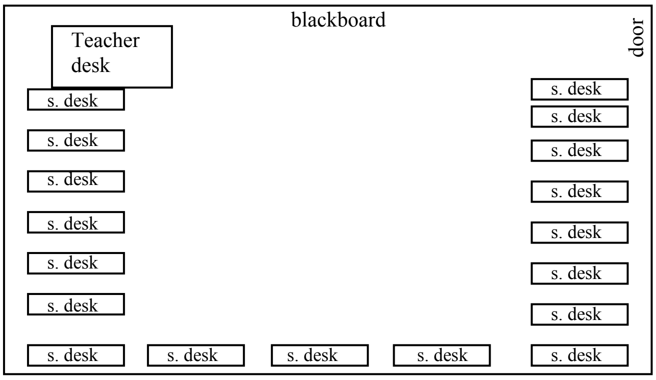

Figure 3.2 The arrangement of the classroom for drama activities which require more available space

In the lessons, carried out with the lesson plans 8 and 9, the arrangement of the desks were changed as in Figure 3.3. In the lessons, students were studied as 4 groups in most of the class time. Organization of the classroom in this way provided effective communication in groups.

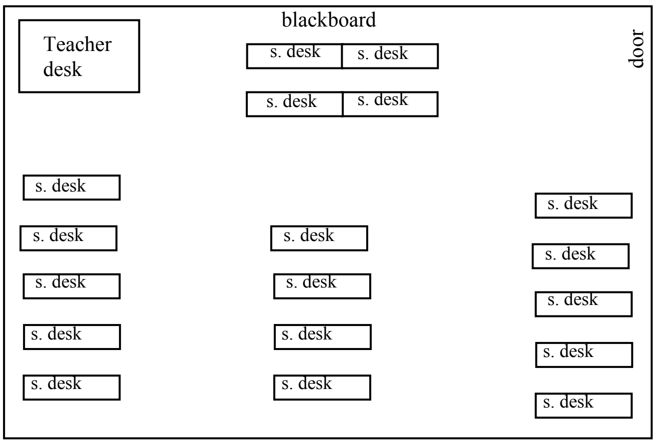

Figure 3.3 The arrangement of the classroom for drama activities which require group communication

There existed three phases in each lesson; (i) introduction, (ii) development, and (iii) quieting.

In the introduction, the first two or three minutes of the lesson, warm up activities were used to make the students ready to be involved in make believe play for the rest of the lesson. The warm-up activities aimed to put everyone go in a relaxed mood, ready to work together in a harmony, trust each other, and also have fun. They also gave students some hidden clues about the rest of the lesson. For example, students were asked to draw imagined circles by using their pinky finger, shoulder, elbow, palm, head, eye, nose etc. in the lesson that covered the positions of a circle and a line with respect to each other. In the lesson that they were introduced the concept of polygon, students were given pictures involving polygons in the form of houses to paint them. At the beginning of lesson related to adjacent and vertical angles, students were asked to walk in the classroom by drawing zigzags or form different angles by using their body related to adjacent complementary and vertical angles.

The development activities, the second phase of the lesson, require students experience and live ideas embellished with geometry in some roles. Students generally work in a group of 4-10; sometimes work as an individual or whole class in this phase. In general, students were introduced with the make-believe plays, which require doing as if something happens or pretending as someone. Make-believe play forms the skeleton of the lesson. It helps to create natural atmosphere for dramatic moments while requiring abstraction and imagination. For example, in the lesson related with adjacent and vertical angles, students were given the role of a TV program producer on the topic of adjacent and vertical angles. In the lesson related to circle, as a make believe play, students were told that they are camping scouts in a forest. In this make-believe environment, students were posed with a dramatic moment. Dramatic moments are hooked the make believe play and stemmed from the conditions of the make believe environment. Students faced the dramatic moments of the tension of time, an obstacle to overcome, mission to accomplish, or status to be challenged. These tensions forced them to remove the obstacle or accomplish the mission in given time. In order to get rid of these tensions, they had to create some ideas and discuss their ideas with their friends. For example, in the first make believe play given above, producing a TV program to present the properties of adjacent complementary and vertical angles in the given limited time is the dramatic moment. In preparing this TV program, students need to discuss characteristics of these types of angles in their groups, prepare adjacent complementary and vertical angles by using their bodies. By this way, they were aimed to understand adjacent complementary and vertical angles, the relationship between the sides of two complementary adjacent angles, the relationship between the sides of two vertical angles, and the relationship between the measures of two vertical angles.

For the second make believe play, finding that how the scouts should be positioned to get heat equally and finding the way of protecting fire and themselves from the rain while everyone gets heat equally from the fire are two dramatic moments which are caused by the conditions of the make believe play i.e. camping conditions. The first one aimed the students to understand that in order to get the heat equally they should be positioned in a ring form. The latter aimed the students to understand that in order to protect the fire and themselves from the rain while they were positioned in the ring form, they should use a shelter covering the interior region of the ring and the ring itself, which is named as circle.

Different drama techniques in education were used to achieve the objectives of the lesson, in this phase of the lesson. Among the drama techniques, still images, holding a meeting, TV program, flashbacks, writing in role, teacher in role, telephone conversation, letters, and mantle of expert were used.

In the development phase, the researcher encouraged students to communicate ideas by questioning. The researcher asked high level questions (to make students speculate and discuss ideas and explain their knowledge) rather than low level questions (recalling facts and figures). For example when a students gave an example of circle as “a ball is a circle” or “a plate is a circle”, the researcher repeated the student’s statement and asked to the class “what do you think about this idea?” in order to provoke discussion. By this way students can display more intricate thought, deeper personal connection, more involvement, and richer inquiry. The researcher also made the students question the others’ ideas. For example, related to the above students’ statements, the researcher asked, “Is every plate can count as a circle?”, ”How should it be in order to be a circle?” By this way the researcher tried to make students question the ideas suggested by their classmates. In some lessons, the researcher asked challenging questions like “are two parallel lines intersecting with other line by an arbitrary angle and two parallel lines intersecting with another line by right angle constitute different positions for three lines". When a group was improvising a concept, the researcher asked questions to other groups related to the ongoing improvisation. When a question was aroused from an individual student or a group, the researcher forwarded the question to other groups to create a discussion environment.

In some lessons, the researcher participated activities by taking some roles such as a scout leader, an evaluator of the TV program or an officer of The Ministry of Forestry. This helped to give directions to the lesson and control the students and the teaching/learning process. This also provides more effective relationships between the teacher and students. For example, by taking the role of an evaluator of the TV program, the researcher had a chance to give feedback to students' TV program about vertical and adjacent angles and make necessary comments.

Finally, in quieting activities phase, the main points of the lesson were emphasized and the key points of the concept covered were summarized either by the teacher or by the students. Students reviewed what they have learned either by answering or solving the questions posed by the teacher, or presenting what they have learned by an improvisation that requires the use of knowledge learned. The analogy created between the real life conditions and the geometry facts by the help of make believe play and dramatic moments were emphasized by the researcher.

In this part for example, students presented the TV program they prepared related to vertical and adjacent angles, formed triangles and their mediums, altitude, angle bisectors by ropes, their bodies or any other material they could find in the classroom, summarized different positions of cut three and fire circle by forming them with their bodies, listed the objects in the shape of ring, and circle in groups. On the other hand, in the lesson on quadrilaterals, area and perimeters of quadrilaterals, the researcher summarized the key points by asking questions to the students. At the end of each topic, homework was also assigned from the textbook named *İlköğretim Matematik 7* (Yıldırım, 2001).

3.6.2 Treatment in the Control Group

The control group students were taught geometry by traditional teaching approach. The traditional instruction environment was based on a textbook approach using chapters related to the angles, polygons, circle and cylinder from *İlköğretim Matematik 7* (Yıldırım, 2001), the adoptive text-book for the seventh grade students. The homework assignments were also given from this textbook.

Generally, the majority of classroom atmospheres were developed around the teacher supplying knowledge to the students. She first explained the concept by writing definitions on the blackboard and by drawing if necessary and solved some examples. Later she allowed students to write them on their notebooks. The lessons were continued by solving questions similar to the examples she solved. The students in this group were passive receivers. They were listening to the teacher, recording what the teacher wrote on the blackboard, solving the questions the teacher asked mainly in their own places. Very rarely, some of the volunteer students solved the questions on the blackboard. The general inclination of the teacher was to solve questions by herself in order to save time to solve more- questions.

3.7 Treatment Verification

At the end of the treatment period, the classroom teacher, who was present in the EG during the study, was given a checklist (see in Appendix K) to determine the degree to which the researcher implemented the lessons according to the lessons plans. As it is seen in the instruction of this checklist, the classroom teacher was asked to grade each lesson ranged from 0 to 5 in terms of the degree to which the researcher implemented the lessons according to the lessons plans. The grade 0 means, “The implemented lesson is totally different than the lesson plans” and grade 5 means, “The lesson is implemented as exactly in the lesson plans”. The classroom teacher graded all lessons as giving them grade 5. Furthermore, the interview responses of the EG students and the classroom teacher were also reckoned as treatment verification.

3.8 Data Analyses

The data gathered through the achievement tests, van Hiele geometric thinking level test, and attitude scales were analyzed by using Statistical Package for Social Sciences 9.0.

Two separate multivariate analyses of covariance (MANCOVA) procedures were employed to answer the first two research problems. The MANCOVA is a statistical technique that measures the effect of independent variable(s) on more than one dependent variables.

In order to compare the mean scores of the control and experimental group on van Hiele geometric thinking level, attitudes toward mathematics, attitudes toward geometry, achievement on angles and polygons, and circle and cylinder and to reveal whether these differences are significant or not while controlling differences between groups for gender, mathematics grade in previous year, the pretest scores on van Hiele geometric thinking level, attitudes toward mathematics and geometry, a MANCOVA was used.

The variables and their entry order are given in Table 3.6. As can be seen in this table, covariates were entered first, the group membership was entered second and the covariate*group interaction set was entered third in the MANCOVA model. The interaction set must be non-significant for the MANCOVA model to be valid. As the MANCOVA results only show significant differences between groups on the collective dependent variables, follow-up analyses of variance (ANCOVAs) were used to look at the effects of drama based instruction on each dependent variable.

At the beginning of the study, the effect size was set to high. In the analyses, the probability of making Type-1 error (probability of the rejecting true null hypothesis) was set to .05, which is commonly used value in educational studies. For this analysis, there were 102 subjects in the sample and five covariates. The statistical power of the study for these values calculated as between .95 and .99.

Table 3.6 The variable-set composition and statistical model entry order for the MANCOVA used for the comparing posttest

Variable set	Entry order	Variable name
A (covariates)	1st	X1= gender X2= MGP X3= PREVHL X4= PREMAS X5= PREGAS
B (group membership)	2nd	X6= Methods of Teaching
C (covariates*group interaction)	3rd	X7= X1 * X6 X8= X2 * X6 X9= X3 * X6 X10= X4 * X6 X11= X5 * X6
D (dependent variables)		Y1 = POSTVHL Y2 = POSTMAS Y3 = POSTGAS Y4 = POSTAPA Y5 = POSTCCA

To compare the mean scores of each group on the delayed post achievement tests on angles and polygons; and circle and cylinder, and to reveal whether the differences are significant or not while controlling differences between groups for gender, mathematics grade in previous year, the posttest scores on angles and polygons; and the circle and cylinder achievement tests, pre and post attitude scores on mathematics and geometry attitude scale, and pre and post test scores on van Hiele geometric thinking level test, another MANCOVA was conducted. Table 3.7 shows all variables and the variable set entry order used in the analyses. After this MANCOVA analysis, follow-up ANCOVAs were used for significant main effects in order to reveal the effects of drama based instruction on each delayed post achievement test.

For the second analysis, there were 96 subjects in the sample and 11 covariates. The statistical power of the study for these values was calculated as between .90 and .95.

Table 3.7 The variable-set composition and statistical model entry order for the second MANCOVA

Variable set	Entry order	Variable name
A (covariates)	1st	X1= gender X2= MGP X3= PREVHL X4= PREMAS X5= PREGAS X6= POSTVHL X7= POSTMAS X8= POSTGAS X9= POSTAPA X10= POSTCCA
B(group membership)	2nd	X11= Methods of Teaching
A*B (covariates*group interaction)	3rd	X12= X1 * X11 X13= X2 * X11 X14= X3 * X11 X15= X4 * X11 X16= X5 * X11 X17= X6 * X11 X18= X7 * X11 X19= X8 * X11 X20= X9 * X11 X21= X10 * X11 X22= X11 * X11
D (dependent variables)		Y1 = DELAPA Y2 = DELCCA

Data received in the interviews were transcribed and read carefully to identify common responses of the students.

3.9 Internal Validity

Internal validity is the extent to which detected differences on the dependent variables are associated with the independent variables and not some uncontrolled variables. Threats to internal validity are alternative explanations of the results that are not related to the treatment. A list of possible threats to the internal validity of the study and how they were minimized or controlled were discussed in this section.

This study was carried on intact groups in which individual students were not randomly assigned to the groups. This might bring the subject characteristics threat to the study. Some characteristics, which could potentially affect the outcomes of the study, were determined. With this respect, students' gender, mathematics grade in previous year, previous van Hiele geometric level, mathematics attitude and geometry attitude were determined as potential extraneous variables to posttests. Additionally, gender, mathematics grade in previous year, prior angles and polygons; circle and cylinder achievement, van Hiele geometric thinking level; attitudes toward mathematics and geometry were determined as potential extraneous variables to delayed posttests. These variables were checked to see whether they had a relation with the dependent variables of the study. Statistically associated variables were included in a covariate set for the related analysis to match the subjects on these variables. By this statistical remedy, individual differences were partially minimized and group equivalency was established. Therefore the subject characteristics threat was removed.

In order to control the history effect, groups were administered all tests approximately at the same time. By this way similar situations were tried to be provided. The results of the treatment may be associated with specific events occurred between pretest and posttest, and between the posttests and delayed posttest. This was not an issue because the length of the study was limited to a semester.

The location, in which data are collected, could provide an alternative explanation for the outcomes of the study. In this study, location was three similar classrooms at the same school. These similar situations and administration of all tests at the mathematics lesson were a remedy for the possible location threats. Beside these, no outside events were observed during the testing period that could influence the subjects' responses.

Another likelihood of threat might be pretesting effect. In other words, the exposure to pretests could change the performance of subject in related posttests. Both groups were administered pretest to equalize the pretesting effect. Moreover, there were eight weeks for the implementation of posttest and 4 months for the delayed posttest. This time periods were assumed to be sufficient for desensitization. Besides, the pretest was treated as a covariate for the posttest analysis, and the pretest and posttests were treated as covariates for the delayed posttest analysis. Thus the effects of these earlier pretesting were partialled out statistically.

Mortality refers to loss of students during the treatment. There were no missing data in all pretests and posttests. However, ten and eight students were not available for the implementation of the APA and the CCA as a delayed posttest, respectively. Since these variables were the dependent variables of the analysis, these subjects were deleted listwise for the analysis of comparing delayed posttests. The losses did not cause a viable threat.

Maturation threat means the results of the treatment may be associated with the passage of time rather than treatment. This was not an issue because the length of the study was limited to one semester. Besides, for both the EG and the CG the same amount of time has passed.

It is possible that the person administering a treatment may be the cause of the results or any observed outcomes. This threat may be the results of teacher differences (e.g. teacher gender, teaching ability, attitude or biases toward the treatment, encouragement, verbal reinforcement, personal mannerism, and adherence to the standardized lesson plans). For the implementation effect the researcher tried to be unbiased during the instruction in the EG group. Beside the classroom teacher was also present in the lessons of the EG to observe the behaviors of the researcher.

An instrumentation threats can be in the form of instrument decay, data collector bias, or inadequate demonstration of reliability and validity of the assessment. In this study although an open-ended questions were used in the achievement tests, each questions were divided into subtasks according to the objectives covered and each tasks were scored as 0 or 1. Therefore, instrument decay was not a viable threat. Data collectors were both the classroom teachers and the researcher. This was helpful to control data collector characteristics and data collector bias.

Furthermore, outcomes of an experimental research might be affected by Hawthorne effect that was not controlled in this study. However, since instructional timeline lasted more than six weeks, any Hawthorne effect that may be caused by the use of novel instruction method washes out.

CHAPTER 4

DEVELOPMENT OF ACHIEVEMENT TESTS AND GEOMETRY ATTITUDE SCALE

4.1 Development of Achievement Tests

The two achievement tests, the angles and polygons achievement test (APA) and the circle and cylinder achievement test (CCA), were developed for this study.

First of all, previously developed questions in textbooks (Balcı, Karahan, Yıldırım, & Özkan, 1995; Buhan & Yeniay, 2000; Karaçay & Baykul, 1986; Taşkın & Serengil, 1999), researches (Burger, & Shaughnessy; 1986; Usiskin, 1982), and teachers' resource books (The Associations of Teachers of Mathematics, 1989; Jamski, 1991; Özer, Budak, Altınordu, & Çatal, 2000) were searched. Then 24 questions for the APA and 25 questions for the CCA were selected by considering the objectives in the National Mathematics Curriculum (MEB, 2000) for the seventh grade geometry. The open ended question format was used, since the aim was to investigate conceptual understanding.

A graduate mathematics student checked these tests for the face and content validity by comparing the content of the tests with the objectives. Then tests were submitted to a mathematics educator in university to check the appropriateness, relevance, and conciseness of the questions. Taking into account her suggestions, some revisions were made on the wordings of questions to make them clear and suitable for the learning outcome being measured.

After that these draft forms of the APA including 24 questions (see Appendix L) and the CCA including 25 questions (see Appendix M) were piloted on 129 and 153 eighth grade students from two state schools respectively in the first semester of 2002- 2003 academic year. The aim of the piloting were to check the clarity of the questions, to make sure the adequacy of the test duration, to determine the difficulty of the questions, to decide the most suitable questions among the overlapping questions, and to establish the scoring criteria for the responses given to each questions.

According to the results of this piloting, the APA was then reviewed as the followings:

- The seven questions, namely questions 5, 8, 10, 13, 14, 15, and 18 were dropped for miscellaneous reasons.

Some of the questions were deleted, as there were overlapping questions. For example the aim of both question 4 and 5 were to check the students' understanding of the relations between the side lengths and the angle measures of a triangle. Since the students' responses did not differ to these questions, one of them was chosen randomly. Thus only question 4 was taken in the final form. The question 9 covered the objectives of both questions 8 and 10 and involves some more objectives like writing the interior angles of equilateral triangles. Considering this, questions 8 and 10 were removed. The correct response rates to questions 13, 14 and 15 were very low; particularly maximum correct response rate was 28 out of 129. Moreover, the objectives of these questions were partly covered by the question 20. These concerns were resulted by the deletion of these questions. Only five students answered question 18, therefore it was dropped because of the difficulty of this question.

- Some revisions were made on questions 2, 7, 12, and 20.

For all these questions, modifications in the presentation were made to make the students consider all details. For example, question 7 in the draft form was adjusted as question 6 in the final form. In the first draft this question, students were asked to write medians, angle bisectors and altitudes of the given shape. It directed some of the students to think one example was enough to answer this question. In the final form, possible medians, angle bisectors and altitudes were supplied to the students as alternatives and they asked to circle the correct one(s). This was aimed to have students think whether all the possible line segments are medians, angle bisectors and altitudes. Question 20 in the draft form was revised as question 10 in the final form. In the final form, tables, involving each quadrilateral given in the figure, were prepared to make students to show their ideas related to all of the quadrilaterals. For example, in part a, students had to consider whether each of these quadrilaterals was square or not. By this way students' understanding of hierarchy of the quadrilaterals could be detected as well.

According to the results the piloting, the CCA was revised as follows:

- Questions 7, 11, 12, 14, 17, 19, 20, 22, 23, and 24 were dropped for several reasons.

Some of the questions were removed, since there were overlapping questions. The objective of questions 7 and 11 namely "identifying arcs in a circle" was covered by questions 10 and 13. Questions 10 and 13 covered some other objectives like finding the measure of the inscribed angle, using the measure of its arc; finding the area of a circle when the diameter is given; and finding the area of a square when the side length is given. Considering these, questions 7 and 11 were deleted.

Question 12 was deleted since the objective of this question namely "identifying measures of an arc in a circle" was assessed by question 13. Since question 13 covered the objective of "finding the measure of the inscribed angle using the measure of its arc" as well, question 12 was dropped.

The objective of question 14 was identifying relations between arcs and angles of circle. This objective was covered by questions 13 and 18. Moreover, questions 13 and 18, covered some other objectives namely "finding the measure of the one of arc in the circle given the measure of the others" and "finding the area of a circle segment given the angle of the segment and the radius". Hence question 14 was deleted.

Question 19 was dropped as the objective of this question namely "calculating the area of a circle segment" was evaluated by question 18. Question 18 was also used to determine students' ability to find the area of a circle given the distance between the center and a point on the circle is given and to find the area of a circle segment given the angle of the segment and the radius. For this reason, question 19 was deleted.

The objective of both questions 20 and 22 was "identifying parts of a cylinder". This objective was covered the objectives of by question 21. Other than this objective, question 21 was aimed to assess the students' ability to write the name of the shapes constitute a right circular cylinder and to draw an open form of a right circular cylinder. Hence questions 20 and 22 were dropped.

Some questions were deleted, as the difficulties of these questions were not appropriate. For example, none of the students were able to answer question 23 and 24 in the piloting, so these questions were deleted. Question 17 was another problematic question. It was a non-routine problem and had a long question stem. Since there were only six correct answers to this question, this question was deleted.

- Some changes were made on questions 5, 10, and 16.

The format of question 5 was revised as question 7 in the final form so that students' responses can be easily graded. In part b of this question students were asked to compare the distance of the chords to the center of the circle by considering chord lengths. In the final form of this question, this part is divided into three tasks. Students were asked to find the nearest and further chord to the center of the circle, given the chord lengths, and explain how the length of the chords and its distance to the center of the circle is related. For all these tasks students were supplied spaces to write their answers.

The wording of question 10 was changed to make it more precise and easily understandable. In the revision of this question, the word “angular” was added to make precise that angular measure is asked in the question. It was changed into question 9 in the final form.

The numbers in some questions were changed to make them easily computable. Since the aim of the questions is not to assess the calculation skills, question 16 in the first draft of the CCA were revised as question 12 in the final form.

The final form of the APA and the CCA can be seen in Appendix A and C, respectively.

4.2 Development of Geometry Attitude Scale

As the construct of attitude has multiple domains; attitude measures include domains of confidence, interest, anxiety, enjoyment, and vocational importance. An item pool of 17 attitudinal statements was prepared to capture thoughts related to interest, enjoyment, anxiety, and confidence. Items representing interest reflected students' personal interest toward the geometry. Enjoyment related items involved students' pleasure when dealing with geometry. Items standing for anxiety involved the behavior of nervousness and tension felt in geometry topics. Items related with confidence reflected the students' confidence in their ability to learn and to perform well on examination on geometry. The initial 17 items were written by considering the previous publications on development of attitude scale (Berberoğlu & Tosunoğlu, 1995; Corbin & Chiachiere, 1995; Edward, 1957; Henerson, Morris, & Fitz-Gibbon, 1978; Oppenheim, 1996; Tezbaşaran, 1996; Zwick & Velicer, 1986) and the previous mathematics attitude scales (Aşkar, 1986; Duatepe & Çilesiz, 1999; Mulhern & Rae, 1998; Watson, 1983) in terms of item format and dimensions. The wordings of the items were checked against Edwards' (1957) criteria for writing attitudinal statements such as “do not use the statement that includes meaning of universals such as, all, always” (p.13).

The hypothesized matches between items and components of the geometry attitude are as follows: items 1, 6, 11, 15, 16, and 17 were belonging to interest to geometry topics; items 2, 4, and 12 were belonging to confidence in geometry topics; items 3, 5, 8, and 10 were belonging to enjoyment of geometry topics; and items 7, 9, 13, and 14 were belonging to anxiety from geometry topics.

The item format of this scale was the five-point Likert scale. Students were asked to rate the statements by marking a five-point Likert scale with the possible responses “strongly agree”, “agree”, “undecided”, “disagree”, and “strongly disagree.” To minimize random responses and reinforce reliable results, the order of the negative and positive statements was mixed.

The first draft of the GAS including 17 (eight indicative, nine contraindicative) items was piloted on 334 eighth grade students from the five public and a private school. Student completed this scale in approximately 12 minutes, but in fact, there was no time limit during the testing. The completed scales were coded as follows: positively worded statement responses were scored as 5 : strongly agree down to 1 : strongly disagree; and for negative statements the scoring was reversed. The recorded data were analyzed by using SPSS 9 statistical computer software. Principal component analysis with a varimax rotation revealed three factors. Eigenvalues, percentages of variances explained by factors, factor loadings of the items and item-total correlation of this version of the geometry attitude scale were given in Table 4.1. Eigenvalues of these factors were greater than 1.45 and they explained 50.7 of the variance in item responses. All items have factor loading of at least .40, concurrent with the suggestions of Thorndike as cited in Corbin and Chiachiere (1995). This analysis revealed that eight items (items 1, 5, 6, 8, 10, 11, 16, and 17) constituted the first factor, seven items (items 3, 7, 9, 12, 13, 15, and 17) constituted the second factor, and the last factor gathered only two items (items 2, and 4).

Table 4.1 Eigenvalues, % of variances explained by factors, factor loadings of the items, and item-total correlation of the draft version of the geometry attitude scale

	Components	1	2	3
	Eigenvalues	4.77	3.46	1.45
	% of Variances	28.09	20.39	8.55
Items	Item-factor correlation	Factor loadings		
1. Okulda daha çok geometri dersi olmasını istemem.	.724	.795	.236	.006
2. Geometri alanında kendime güveniyorum.*	.595	.500	.155	.505
3. Geometri konuları olmasa okul daha zevkli olabilirdi.*	.553	.436	.560	-.334
4. Geometriden yüksek notlar alabilirim.*	.546	.497	.219	.566
5. Geometri sorularını çözmekten zevk almam.	.707	.706	.188	.329
6. Matematikte diğer konulara göre geometriyi daha çok severek çalışırım.	.671	.667	.261	.154
7. Matematikte en çok korktuğum konular geometri konularıdır.	.575	.206	.668	.114
8. Matematiğin en zevkli kısmı geometridir.	.647	.783	.008	-.006
9. Geometri konuları işlenirken bir tedirginlik duyarım.	.460	.002	.567	.316
10. Geometri çalışırken vaktin nasıl geçtiğini anlamıyorum.	.648	.671	.176	.135
11. Geometri konuları ilgimi çekmez.	.704	.652	.269	.255
12. Geometri sınavından çekinmem.	.531	.006	.743	.103
13. Geometri konuları işlenirken kendimii huzursuz hissediyorum.	.674	.324	.653	.137
14. Geometri konuları işlenirken gerginlik hissetmem.	.638	.203	.717	.241
15. Matematik konuları içinde en sevimsizi geometri konularıdır.*	.558	.411	.549	-.008
16. Geometriyi seviyorum.	.762	.774	.193	.239
17. Geometrinin can sıkıcı olduğunu düşünüyorum.*	.661	.542	.460	-.125

* dropped items

According to Zwick & Velicer's (1986) proposition of "at least three significant loading is required for factor identification" (p .432), the last factor with two significant loadings cannot be treated as a factor. Moreover, the items constitute this factor also loaded on the first factor. The careful examination of the factor loading showed that, in addition to items complied under the last component; items 3, 15, and 17 were also problematic as they loaded on both the first two factors. With these considerations, item 2, 3, 4, 15 and 17 were dropped. The remaining 12 items showed that, items hypothesized as related to interest and enjoyment worked together and items hypothesized as representing anxiety and confidence worked together. The first factor, involving interest and enjoyment related items, indicated .88 and the second factor, involving anxiety and confidence related items, indicated .75 Cronbach alpha reliability estimate.

Then, the revised form of 12-item geometry attitude scale was administered on 126 eight grade students from three public and a private schools different from the previous sample. The principal component analysis with varimax rotation revealed two factors explaining 67.5 of the variance in item responses. Table 4.2 presents the eigenvalues, percentage of variances explained by factor, factor loadings of the items, and item-total correlation of the last version of the geometry attitude scale. Results of factor structure analysis were generally favorable with regard to the validity of scores. Eigenvalue of the first dimension was 4.55 and the second dimension was 3.55 and the factor loadings ranged between .84 and .60. Seven statements reflecting the interest and enjoyment to geometry grouped into one factor and five statements reflecting confidence and anxiety grouped into the other factor. These factors were decided to be named as the interest and enjoyment; and confidence and anxiety dimensions, respectively. The first dimension indicated .92 and the second dimension .87 Cronbach alpha reliability estimate. The scale generally indicated a coefficient of .93.

Table 4.2 Eigenvalues, % of variances explained by components, factor loadings of the items, and item-total correlation of the last version of the geometry attitude scale

		Components	Interest and Enjoyment Dimension	Confidence and Anxiety Dimension	
		Eigenvalues	4.55	3.55	
Item no		% of Variances	37.9	29.6	
draft from	final form	Statement	Factor loadings		Item-total correlation
11	6	Geometri konuları ilgimi çekmez.	**.84**	.28	.722
16	7	Geometriyi seviyorum.	**.82**	.37	.799
8	11	Matematiğin en zevkli kısmı geometridir.	**.80**	.25	.710
5	9	Geometri sorularını çözmekten zevk almam.	**.79**	.31	.714
6	2	Matematikte diğer konulara göre geometriyi daha çok severek çalışırım.	**.75**	.26	.766
1	1	Okulda daha çok geometri dersi olmasını istemem.	**.66**	.39	.683
10	10	Geometri çalışırken vaktin nasıl geçtiğini anlamıyorum.	**.60**	.34	.682
9	4	Geometri konuları işlenirken bir tedirginlik duyarım.	.28	**.84**	.675
13	8	Geometri konuları işlenirken kendimi huzursuz hissediyorum.	.27	**.80**	.799
14	5	Geometri konuları işlenirken gerginlik hissetmem.	.29	**.79**	.719
12	12	Geometri sınavından çekinmem	.33	**.73**	.575
7	3	Matematikte en çok korktuğum konular geometri konularıdır.	.34	**.60**	.757

CHAPTER 5

RESULTS

This chapter is divided into four sections. The first section presents descriptive statistics of the data. The second and the third section present quantitative results and the qualitative results, respectively. The last one summarizes the research findings.

5.1 Descriptive Statistics

5.1.1 Descriptive Statistics of the Angles and Polygons Achievement Test

Descriptive statistics related with the POSTAPA and the DELAPA for the EG and the CG appear in Table 5.1. As it is seen in this table, the EG mean scores on both the POSTAPA and the DELAPA were higher than the CG mean scores. From immediate posttest to delayed posttest, mean scores of both groups declined. While the EG mean score decreased from 173.49 to 145.08, the CG mean score decreased from 91.82 to 86.97.

Table 5.1 Descriptive statistics related with the POSTAPA and the DELAPA for the EG and the CG

	Experimental Group		Control Group	
	POSTAPA	DELAPA	POSTAPA	DELAPA
N	68	60	34	32
Mean	173.49	145.08	91.82	86.97
Median	183	139	99.5	81
Standard Deviation	58.71	35.50	38.80	32.37
Skewness	-.754	.387	-.138	.756
Kurtosis	.673	.349	-.777	.396
Maximum	274	237	176	175
Minimum	19	65	26	35

The clustered boxplots of the POSTAPA and the DELAPA are plotted in Figure 5.1. As the figure indicated, there was a lower outlier in the POSTAPA of the EG. One higher outlier appears in the DELAPA of both groups. In boxplot, the box contains mid 50 % percent and each whisker represents upper and lower 25 % of the cases. According to that, the first quartiles of the POSTAPA and the DELAPA of the EG were at the same level with the second and the third quartiles of the POSTAPA and the DELAPA of the CG, respectively. The lower 50 % of the POSTAPA of the EG ranged between 19 and 183. On the other hand, the upper 50 % of the CG scores lied between 99.5 and 175 for the POSTAPA. When we looked at the DELAPA, the lower 50 % of the EG subjects got between 65 and 145. This interval almost involves all cases for the CG, except for the one upper outlier. Namely the maximum scores of the CG was about the median scores of the EG for both tests.

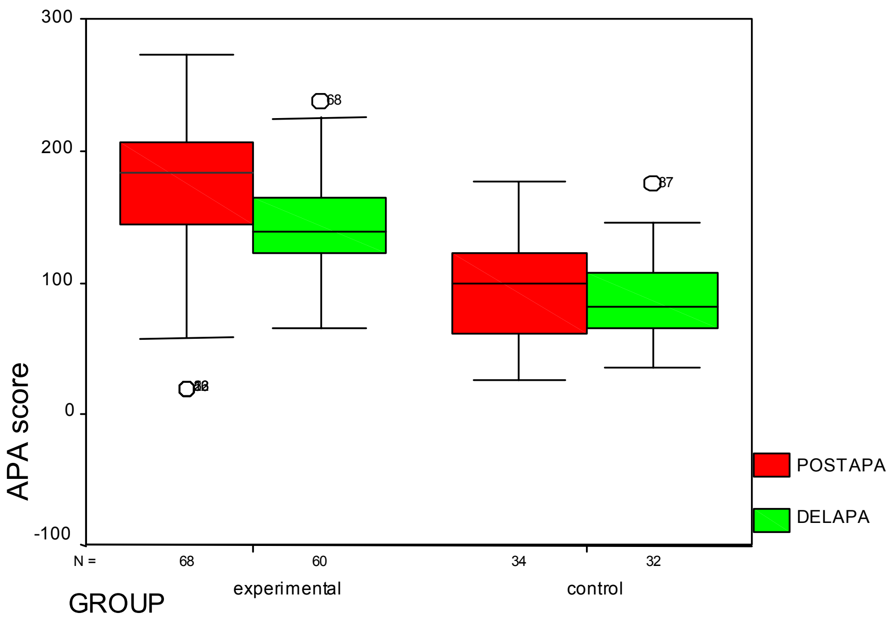

Figure 5.1 Boxplot of the POSTAPA and the DELAPA for the EG and the CG

The frequencies and percentages of the correct responses of both groups on each task of the POSTAPA and the DELAPA were calculated to see how this difference is distributed for each task of the test (see Appendix B). The frequencies and percentages of the correct responses show that, for most of the tasks, except for the eight tasks of the POSTAPA, the EG students' correct response percentages were higher than the CG students' correct response percentages. Among these eight tasks, on five of them the CG correct response percentages were slightly higher; on three of them both groups correct responses were equal. When these eight tasks were examined, it was seen that almost all these tasks were related with the topic of quadrilateral, particularly as regards to identifying square and rectangle.

The comparison of the DELAPA of the EG and the CG revealed that apart from 20 tasks, the EG students' correct response percentages were higher than the CG students' correct response percentages. The correct response frequencies of the CG were slightly higher for these 20 tasks. Among these 20 tasks, 18 of them again related with identifying square and rectangle as for the POSTAPA.

As it was stated before, mean of the DELAPA were lower than the POSTAPA for both groups. For the EG, there were sharp decreases in correct response frequencies for the tasks related with triangular inequalities; identifying non-polygons; identifying square, rectangle, rhombus; finding area of square, diamond, rhombus and parallelogram.

On the other hand, it is seen that correct responses to some of the tasks increased. These tasks were on the topic of angles of triangle, for the EG students. On the other hand, there is no sharp decrease or increase for the correct response percentages of the CG.

5.1.2 Descriptive Statistics of the Circle and Cylinder Achievement Test

Table 5.2 presents descriptive statistics of the groups related with the POSTCCA and the DELCCA. The EG mean scores' on both the POSTCCA and the DELCCA were higher than the mean scores of the CG. Mean scores of both groups demonstrated a decrease from immediate to delayed posttest. While the EG showed a mean decrease of 2.35, the CG showed a mean decrease of 6.57.

Table 5.2 Descriptive statistics related to the POSTCCA and the DELCCA for the EG and the CG

	Experimental Group		Control Group	
	POSTCCA	DELCCA	POSTCCA	DELCCA
N	68	62	34	32
Mean	22.74	20.39	9.78	3.21
Median	21	19	9	3
Standard Deviation	8.36	10.83	5.48	2.43
Skewness	.442	.359	.990	1.148
Kurtosis	-.885	-.502	.780	1.234
Maximum	42	44	23	10
Minimum	10	1	2	0

To compare the distribution of the scores visually, the clustered box plots of the POSTCCA and the DELCCA was constructed (see Figure 5.2). As the figure indicates, there are two upper outliers in the POSTCCA and the DELCCA for the CG. Both the POSTCCA and the DELCCA scores of the EG were higher than the CG. While the median of the EG score slightly decreased from the POSTCCA to the DELCCA, the upper and the lower half of the cases lied almost in the same interval. Conversely the interval of the POSTCCA and the DELCCA scores of the CG was considerably changed. While the maximum scores in the DELCCA (except for outliers) had not reached even the median of the POSTCCA, the median of the DELCCA is about the minimum score of the POSTCCA for this group.

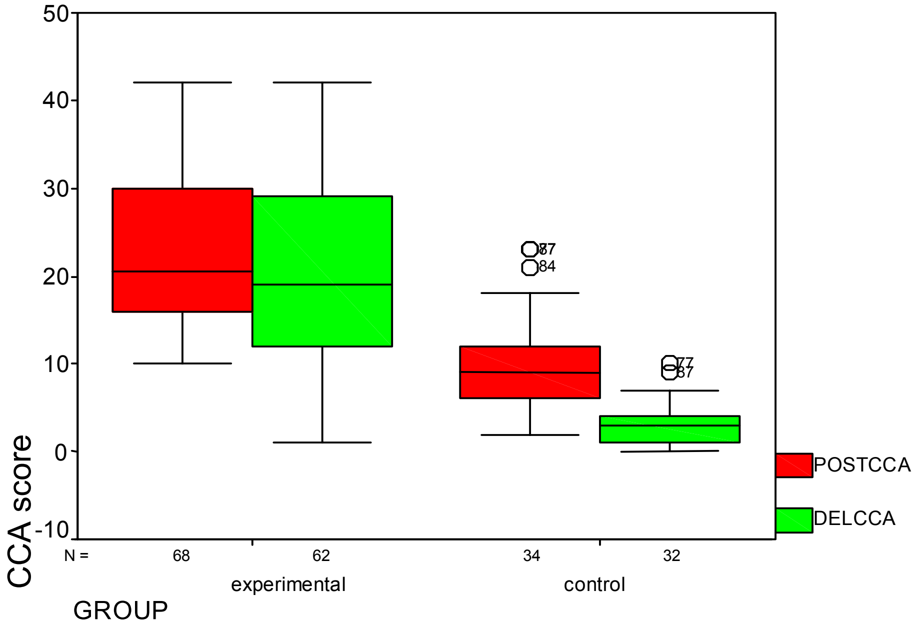

Figure 5.2 Boxplot of the POSTCCA and the DELCCA for the EG and the CG

In order to see the distribution of the differences for each task of the test, the frequencies and percentages of correct responses to the POSTCCA and DELCCA were computed (see Appendix D). From the POSTCCA to the DELCCA there were sharp decreases in correct response frequencies of tasks related with drawing points in the inside, at the outside and on the circle; comparing a chord and a radius of a circle; relation between chord and arcs; area of a circle; and finding area and volume of a cylinder for the EG. On the other hand, the CG students' percentages of correct responses sharply decreased for tasks related with tangent, angles of circle, relation between chord and arcs, drawing open cylinder, area and volume of cylinder.

When the frequencies of correct responses of the groups were compared, it is seen that, except for only one task of the POSTCCA, the EG students' correct response frequencies of all tasks for both the POSTCCA and the DELCCA were higher than the CG students' correct response frequencies. Only the task concerning angles of a circle, the correct response frequencies of the POSTCCA were equal for both the EG and the CG students.

5.1.3 Descriptive Statistics of the Van Hiele Geometric Thinking Level Test

Table 5.3 shows descriptive statistics related with the PREVHL and POSTVHL for the EG and the CG. As it is seen from the table, the PREVHL mean score of the EG was lower that of the CG. On the other hand, while the mean of the EG increased from 6.15 to 7.41, mean score of CG decreased from 7.40 to 6.16 from pretest to posttest. For the POSTVHL scores, mean score of the EG was higher than the CG mean scores.

Table 5.3 Descriptive statistics related with the PREVHL and the POSTVHL for the EG and the CG

	Experimental Group		Control Group	
	PREVHL	POSTVHL	PREVHL	POSTVHL
N	68	68	34	34
Mean	6.15	7.41	7.40	6.16
Median	6	7.5	8	6.5
Standard Deviation	1.63	2.06	2.35	2.35
Skewness	.035	.183	-.745	-.593
Kurtosis	-.386	-.258	.465	-.039
Maximum	9	12	12	10
Minimum	3	4	2	1

Figure 5.3 shows the clustered boxplot of the PREVHL and the POSTVHL for the EG and the CG. For the EG, the median of the POSTVHL score was in the fourth quartile of the PREVHL score. For the CG, on the other hand, the interval where the lower half of the PREVHL contains the first three quartiles for the POSTVHL.

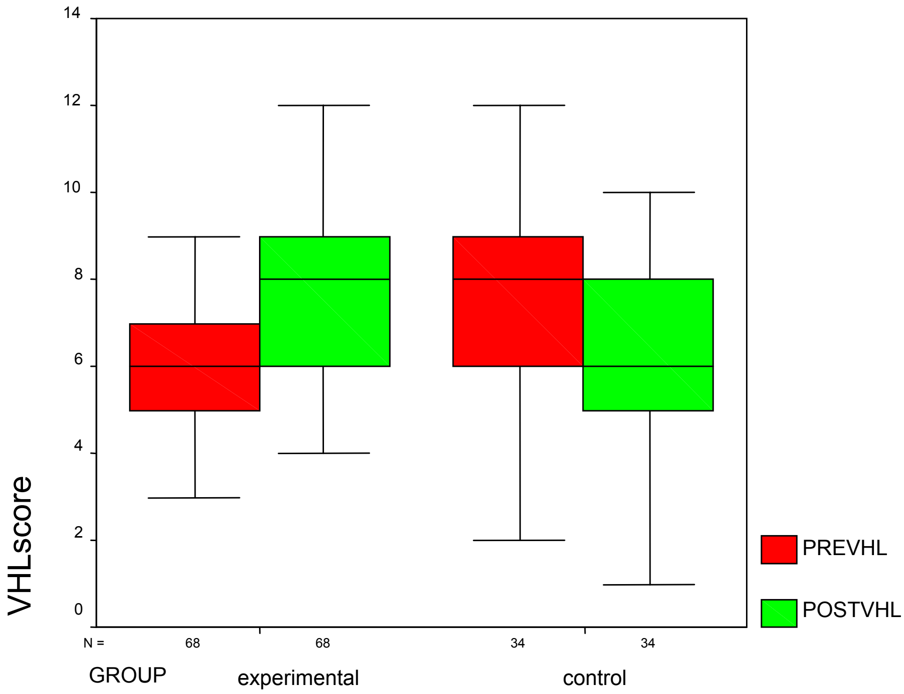

Figure 5.3 Boxplot of the PREVHL and the POSTVHL for the EG and the CG

As stated previously, the mean of the PREVHL score of the EG was lower than that of the CG. When we compared the correct response frequencies of each question for both groups, correct responses of the CG except for three questions (question 1, 7 and 12) were higher than the EG (see Appendix F). When we looked at the correct response frequencies of the POSTVHL, correct responses of the EG to all questions were higher than the correct responses of the CG.

For the EG, the correct response frequencies of each question increased from pretest to posttest. The correct response frequencies of the CG, however, decreased from the pretest to posttests, particularly in the first and the third level questions. These sharp decreases in the correct response frequencies appear on the questions related with identifying triangle, square, and parallelogram; comprehending hierarchy between square and rectangle, comparing rectangle and parallelogram, ordering properties of triangle. For example, the correct response frequency for the first level questions indicated that, an increase to the alternatives involves the prototype examples was detected.

Furthermore, the response of the CG to the third level questions pointed out that fewer students chose the alternatives implied that the “square is also rectangle” in the posttest. In addition to that, the frequencies showed that smaller number the CG students realized the relationship between sides and angles of a triangle from pretest to posttest. This implied that students failed to logically order shapes and properties of shapes.

5.1.4 Descriptive Statistics of the Mathematics Attitude Scale

The descriptive statistics related with the PREMAS and the POSTMAS for the EG and the CG is shown in Table 5.4. As the table shows, both the PREMAS and the POSTMAS mean score of the EG were higher than those of the CG. Yet, while the mean score of the EG increased from 60.36 to 63.23, the mean score of the CG decreased from 50.28 to 49.62 from pretest to posttest.

Table 5.4 Descriptive statistics related with the PREMAS and the POSTMAS for the EG and the CG

	Experimental Group		Control Group	
	PREMAS	POSTMAS	PREMAS	POSTMAS
N	68	68	34	34
Mean	60.36	63.23	50.28	49.62
Median	63.5	63.5	48	50.5
Standard Deviation	23.05	21.66	22.44	19.98
Skewness	-.216	-.266	.255	.288
Kurtosis	-1.095	-.435	-.887	-.688
Maximum	100	100	95	95
Minimum	20	20	13	20

The clustered boxplots of the PREMAS and the POSTMAS can be seen in Figure 5.4. As the mean score of the EG showed and increase of 2.87 from pretest to posttest, distribution of the PREMAS and the POSTMAS were very similar. While the median almost remained same, the interval of first quartile expanded. Similarly, the distribution of the CG scores showed only trivial changes. While the median remained same, the interval of lower 50 % of the scores got smaller. The minimum score increased from 13 to 20, from pretest to posttest.

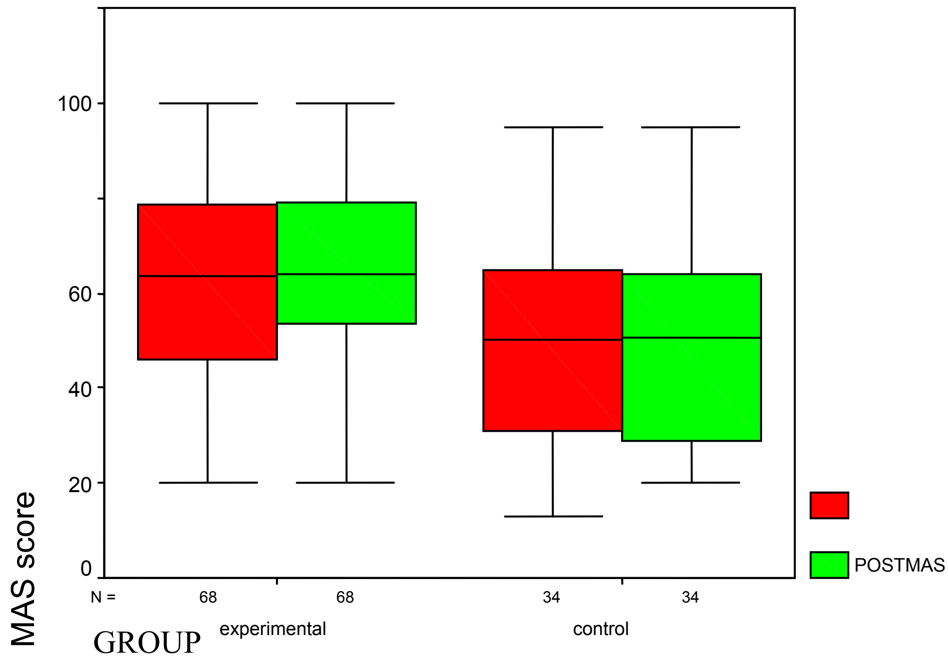

Figure 5.4 Boxplot of the PREMAS and the POSTMAS for the EG and the CG

5.1.5 Descriptive Statistics of the Geometry Attitude Scale

The descriptive statistics related with the PREGAS and the POSTGAS for the EG and the CG appears in Table 5.5. Both the mean of the PREGAS and the POSTGAS of the EG was higher than that of the CG. The EG and the CG increased their mean scores from 36.92 to 41.44 and from 30.53 to 32.53, respectively.

Table 5.5 Descriptive statistics related with the PREGAS and the POSTGAS for the EG and the CG

	Experimental Group		Control Group	
	PREGAS	POSTGAS	PREGAS	POSTGAS
N	68	68	34	34
Mean	36.92	41.44	30.53	32.53
Median	38	44	30	33

Table 5.5 (continued)

Standard Deviation	14.10	13.70	11.18	13.52
Skewness	-.147	-.700	.256	.148
Kurtosis	-.915	-.628	-.498	-.972
Maximum	60	60	55	59
Minimum	11	12	12	12

The clustered boxplots of the PREGAS and the POSTGAS appear in Figure 5.5. As seen from the figure, the median scores of both the EG and the CG slightly increased from pretest to posttest. The distributions of the PREGAS and POSTGAS were similar for each group.

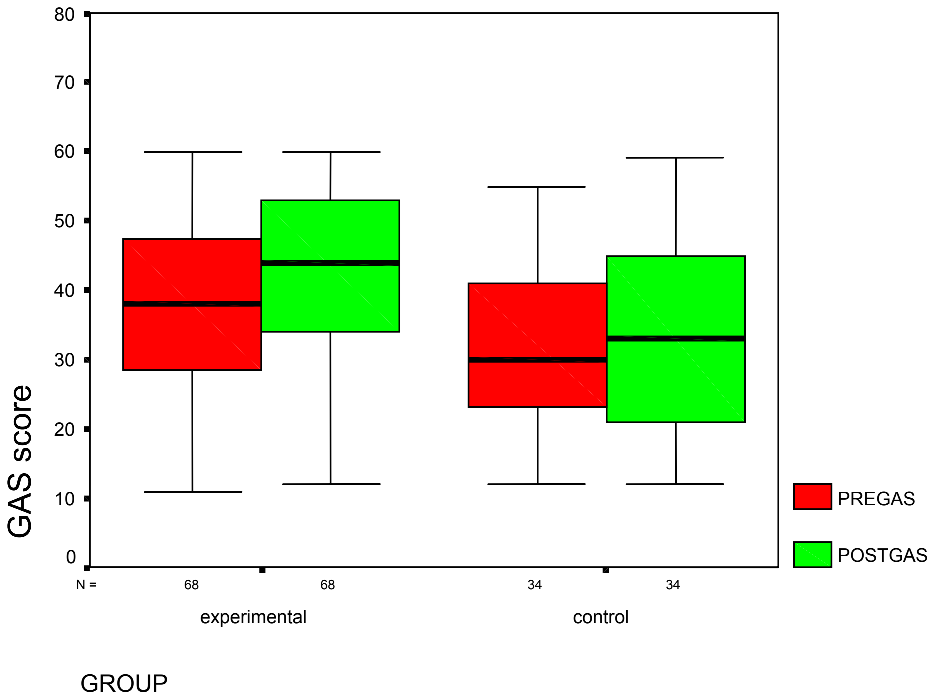

Figure 5.5 Boxplot of the PREGAS and POSTGAS for the EG and the CG

5.2 Quantitative Results

5.2.1 Missing Data Analyses

There were no missing data in all pretests and posttests. On the other hand, eight and two students did not take the APA as a delayed posttest from the EG and the CG, respectively. Six and two students did not take the CCA as delayed posttest. Since these variables were the dependent variables of the analysis, these subjects were deleted listwise for the analysis of comparing delayed posttests.

Some students did not answer some questions of achievement tests and geometric thinking level test. The missing questions in achievement tests were coded as wrong during the analyses. The missing items in attitude scales were coded as mean of possible alternatives.

5.2.2 Determination of Covariates

Prior to conducting the MANCOVA used for comparing the POSTVHL, the POSTMAS, the POSTGAS, the POSTAPA and the POSTCCA, five independent variables; gender, the MGP, the PREVHL, the PREMAS, and the PREGAS were determined as potential confounding factors. In order to determine which of these should be considered as covariates, these potential covariates were correlated with the dependent variables. The correlations and their significance appear in Table 5.6. As it is seen from Table 5.6, all the potential covariates had significant correlations with at least one dependent variable. Therefore, all of them were determined as covariates of the MANCOVA comparing posttests scores.

Table 5.6 Correlation coefficients between independent and dependent variables and their significance for the MANCOVA comparing posttests scores

	Dependent Variables				
	POSTVHL	POSTMAS	POSTGAS	POSTAPA	POSTCCA
Independent Variables					
Gender	-.003	.214*	.078	-.186	-.067
MGP	.216*	.352*	.349	.438*	.531*
PREVHL	.246*	-.064	-.033	.008	-.091
PREMAS	.279*	.508*	.468*	.208*	.314*
PREGAS	.309*	.413*	.395*	.307*	.380*

* Correlation is significant at the .05 level (2-tailed).

For the MANCOVA used for comparing the DELAPA and the DELCCA, ten independent variables; gender, the MGP, the PREVHL, the PREMAS, the PREGAS, the POSTVHL, the POSTMAS, the POSTGAS, the POSTAPA and the POSTCCA were determined as potential confounding variables. To determine covariates, these variables were correlated with the DELAPA and the DELCCA. The correlations and their significance are given in Table 5.7. According to the results appear in Table 5.7, all potential covariates except for the PREVHL had significant correlations with at least one of dependent variables. Hence, apart from the PREVHL all of them were considered as covariates.

Table 5.7 Correlation coefficients between independent and dependent variables and their significance for the MANCOVA comparing delayed posttests scores

	Dependent Variables	
	DELAPA	DELCCA
Independent Variables		
Gender	-.349*	-.004
MGP	.355*	.444*
PREVHL	-.121	-.126
PREMAS	.209*	.314*
PREGAS	.292*	.405*
POSTVHL	.333*	.340*
POSTMAS	.262*	.417*
POSTGAS	.319*	.418*
POSTAPA	.778*	.757*
POSTCCA	.738*	.883*

* Correlation is significant at the .05 level (2-tailed).

5.2.3 Assumptions of the MANCOVA

All the variables were tested for the assumptions of the MANCOVA. These assumptions are normality, homogeneity of regression, equality of variances, multicollinearity and independency of observations.

For the normality assumption, skewness and kurtosis values of the scores should be checked (Pallant, 2001). As cited by Gürçay (2003), the values between –2 and +2 can be assumed as approximately normal for skewness and kurtosis. As it is seen in Table 4.1, 4.2, 4.3, 4.4 and 4.5, skewness and kurtosis values were in the acceptable range for a normal distribution. Table 5.8 and 5.9 display the Box's test of equality of covariance matrices for the MANCOVA used for comparing posttests and delayed posttest, respectively. According to these tables, observed covariance matrices of the dependent variables were equal across groups. This indicates that the multivariate normality assumption for both analyses was satisfied.

Table 5.8 Box's test of equality of covariance matrices for the MANCOVA comparing posttests scores

Box's M	13.351
F	.833
df1	15
df2	18275
Sig.	.641

Table 5.9 Box's test of equality of covariance matrices for the MANCOVA comparing delayed posttests scores

Box's M	6.506
F	2.133
df1	3
df2	11411
Sig.	.141

Homogeneity of regression assumption requires that the regression of dependent variables on covariates must be constant over different values of a group membership. In order to check this assumption, Multivariate Regression Correlation (MRC) was conducted. For the MANCOVA used for comparing posttests, five interaction terms were produced by multiplying the group membership with the covariates of gender, the MGP, the PREVHL, the PREMAS, and the PREGAS, separately. Covariate variables were set to Block 1, group membership was set to Block 2 and the interaction terms set to Block 3. Then, to test the significance of R^2 change, the MRC was performed using enters method for each variable. Table 5.10 shows the result of the MRC. As it is seen from this table, the contribution of Block 3 is not significant for the POSTVHL, the POSTMAS, the POSTGAS, the POSTAPA, and the POSTCCA [$F(5,90) = 1.215$, $p = .308$, $F(5,90) = 0.435$, $p = .823$, $F(5,90) = 0.190$, $p = .966$, $F(5,90) = 0.761$, $p = .580$, and $F(5,90) = 1.318$ $p = .263$, respectively]. These results indicated that, there were no significant interactions between covariates and the group membership; therefore the interactions (Block 3) can be dropped.

This implied that the homogeneity of regression assumption is validated for this analysis.

Table 5.10 Results of the MRC analysis of homogeneity of regression for the MANCOVA comparing posttests scores

Model	Change Statistics				
	R^2 Change	F Change	df1	df2	Sig. F Change
POSTVHL					
Block 1	.195	4.644	5	96	.001
Block 2	.113	15.459	1	95	.000
Block 3	.044	1.215	5	90	.308
POSTMAS					
Block 1	.390	12.290	5	96	.000
Block 2	.011	1.753	1	95	.189
Block 3	.014	.435	5	90	.823
POSTGAS					
Block 1	.346	10.137	5	96	.000
Block 2	.002	.364	1	95	.548
Block 3	.007	.190	5	90	.966
POSTAPA					
Block 1	.259	6.709	5	96	.000
Block 2	.329	75.905	1	95	.000
Block 3	.017	.761	5	90	.580
POSTCCA					
Block 1	.406	13.103	5	96	.000
Block 2	.293	92.640	1	95	.000
Block 3	.021	1.318	5	90	.263

For the MANCOVA used for comparing delayed posttests, ten interaction terms were produced by multiplying the group membership with the covariates of gender, the MGP, the PREMAS, the PREGAS, the POSTVHL, the POSTMAS, the POSTGAS, the POSTAPA, and the POSTCCA, separately. Variables and interaction terms were set to blocks as it is defined above and the MRC was performed to test the significance of R^2 change for each variable. Table 5.11 shows the result of this MRC. As it is seen from this table, the contribution of Block 3 is not significant for the DELAPA and the DELCCA, [$F(10,70) = 0.779$, $p= .649$; and $F(10,72) = 3.437$, $p= .299$, respectively]. Namely, there were no significant interactions between covariates and the group membership; therefore the interactions (Block 3) can be deleted. This showed that the homogeneity of regression assumption is validated for this MANCOVA.

Table 5.11 Results of the MRC analysis of homogeneity of regression for the MANCOVA comparing delayed posttests scores

Model	Change Statistics				
	R^2 Change	F Change	df1	df2	Sig. F Change
DELAPA					
Block 1	.725	21.376	9	81	.000
Block 2	.020	6.215	1	80	.015
Block 3	.026	.779	9	71	.649
DELCCA					
Block 1	.755	33.474	9	83	.000
Block 2	.015	5.699	1	82	.019
Block 3	.047	3.437	9	73	.299

The equality of variance assumptions was satisfied by the result of the Levene's test of equality. Table 5.12 and 5.13 presents the Levene's Test of equality of error variances for the MANCOVA used for comparing posttest scores and for comparing delayed posttest scores, respectively. As it is seen from these tables, all F values are non-significant which mean that the error variances of the dependent variables across groups were equal for both analyses.

Table 5.12 Levene's test of equality of error variances for the MANCOVA comparing posttest scores

	F	df1	df2	sig
POSTVHL	0.147	1	100	.702
POSTMAS	0.037	1	100	.847
POSTGAS	1.688	1	100	.197
POSTAPA	0.020	1	100	.888
POSTCCA	0.056	1	100	.814

Table 5.13 Levene's test of equality of error variances for the MANCOVA used for comparing delayed posttest scores

	F	df1	df2	Sig.
DELAPA	0.009	1	90	.927
DELCCA	1.257	1	90	.265

For the multicollinearity assumptions, the correlations between covariates were checked. Correlations between covariates and their significance are given in Table 5.14. Since the correlations between covariates were smaller than .8, assumption of multicollinearity was satisfied.

Table 5.14 Correlations between covariates

	MGP	PREVHL	PREMAS	PREGAS	POSTVHL	POSTMAS	POSTGAS	POSTAPA	POSTCCA
Gender	-.11	-.01	.19	.08	-.00	.21*	.06	-.19	-.08
MGP	1.0	.19	.12	.23*	.21*	.21*	.16	.43*	.54*
PREVHL		1.0	-.17	-.10	.24*	-.03	-.06	.01	-.06
PREMAS			1.0	.67*	.28*	.56*	.49*	.21*	.29*
PREGAS				1.0	.31*	.53*	.56*	.26*	.40*
POSTVHL					1.0	.24*	.14	.39*	.39*
POSTMAS						1.0	.60*	.19	.34*
POSTGAS							1.0	.17	.33*
POSTAPA								1.0	.78*

* Correlation is significant at the .05 level (2-tailed).

Independency of observations was not a statistical assumption, simply means that each participant responded independently from other participants. This assumption was supplied by the observations of the researcher during the administration of the all tests. All subjects did all tests by themselves.

5.2.4 Inferential Statistics

In this part the findings of the analyses to answer the research questions will be presented in the order of research questions.

What are the effects of drama based instruction compared to traditional teaching method on seventh grade students' Van Hiele geometric thinking level, attitudes toward mathematics, attitudes toward geometry, achievement on angles and polygons, and circle and cylinder when students' gender, mathematics grade in previous year, prior Van Hiele geometric thinking level, attitudes toward mathematics and geometry are controlled?

In order to answer this question, data were analyzed by using a multivariate analysis of covariance (MANCOVA). The results of this analysis are presented in Table 5.15. As it is seen from the table, significant differences were found (λ = .385, p = .000) between groups in the favor of the drama based instruction group on the collective dependent variables of the POSTVHL, the POSTGAS, the POSTMAS, the POSTAPA, and the POSTCCA, simultaneously.

Table 5.15 Multivariate tests results for the MANCOVA comparing posttest scores

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
Intercept	.882	2.419	5	91	.042	.118	.743
GENDER	.926	1.444	5	91	.216	.074	.487
MGP	.496	18.271	5	91	.000	.504	1.000
PREMAS	.833	3.597	5	91	.005	.167	.909
PREGAS	.940	1.158	5	91	.336	.060	.394
PREVHL	.856	3.026	5	91	.014	.144	.845
MOT	.385	28.735	5	91	.000	.615	1.000

In order to test the effect of the methods of teaching on dependent variables of the POSTAPA, the POSTCCA, the POSTVHL, the POSTMAS, and the POSTGAS, a univariate analysis of covariance (ANCOVA) was conducted as follow-up tests of the MANCOVA. The results of the ANCOVA can be seen in Table 5.16. As it is seen from the table, a statistically detectable difference was seen for the POSTAPA, the POSTCCA, the POSTVHL, the POSTMAS, and the POSTGAS between groups in the favor of experimental group [F (1,95) = 76.008, p = .000; F (1,95) = 91.381, p = .000; F (1, 95) =6.599, p = .012; F (1,95) = 5.665 p = .019, and F (1,95) = 15.473, p = .000, respectively]. This means that students taught by drama based instruction got higher scores on each posttest than the students instructed by traditional method.

Table 5.16 Tests of between-subjects effects

Source	Dependent Variable	df	F	Sig.	Eta Squared	Observed Power
Corrected Model	POSTAPA	6	22.653	.000	.589	1.000
	POSTCCA	6	35.954	.000	.694	1,000
	POSTMAS	6	11.009	.000	.410	1.000
	POSTGAS	6	8.765	.000	.356	1.000
	POSTVHL	6	6.982	.000	.306	.999
Intercept	POSTAPA	1	4.252	.042	.043	.532
	POSTCCA	1	.185	.668	.002	.071
	POSTMAS	1	1.238	.269	.013	.196
	POSTGAS	1	1.632	.205	.017	.244
	POSTVHL	1	3.235	.075	.033	.429
GENDER	POSTAPA	1	7.919	.006	.077	.795
	POSTCCA	1	2.090	.152	.022	.299
	POSTMAS	1	.964	.329	.010	.163
	POSTGAS	1	.099	.753	.001	.061
	POSTVHL	1	.224	.637	.002	.076
MGP	POSTAPA	1	32.819	.000	.257	1.000
	POSTCCA	1	77.438	.000	.449	1.000
	POSTMAS	1	13.683	.000	.126	.956
	POSTGAS	1	11.763	.001	.110	.924
	POSTVHL	1	1.352	.248	.014	.210
PREVHL	POSTAPA	1	2.036	.157	.021	.292
	POSTCCA	1	.024	.878	.000	.053
	POSTMAS	1	.353	.554	.004	.091
	POSTGAS	1	.055	.815	.001	.056
	POSTVHL	1	13.910	.000	.128	.958
PREMAS	POSTAPA	1	.184	.669	.002	.071
	POSTCCA	1	1.794	.184	.019	.264
	POSTMAS	1	13.070	.000	.121	.947
	POSTGAS	1	10.680	.002	.101	.899
	POSTVHL	1	1.058	.306	.011	.175
PREGAS	POSTAPA	1	.603	.439	.006	.120
	POSTCCA	1	1.397	.240	.014	.216
	POSTMAS	1	1.250	.266	.013	.198
	POSTGAS	1	.893	.347	.009	.155
	POSTVHL	1	3.236	.075	.033	.429
MOT	POSTAPA	1	76.008	.000	.444	1.000
	POSTCCA	1	91.381	.000	.490	1.000
	POSTMAS	1	6.599	.012	.065	.720
	POSTGAS	1	5.665	.019	.056	.654
	POSTVHL	1	15.473	.000	.140	.973
Error	POSTAPA	95				
	POSTCCA	95				
	POSTMAS	95				
	POSTGAS	95				
	POSTVHL	95				

Table 5.16 (continued)

Source	Dependent Variable	df	F	Sig.	Eta Squared	Observed Power
Total	POSTAPA	102				
	POSTCCA	102				
	POSTMAS	102				
	POSTGAS	102				
	POSTVHL	102				
Corrected Total	POSTAPA	101				
	POSTCCA	101				
	POSTMAS	101				
	POSTGAS	101				
	POSTVHL	101				

What are the effects of drama based instruction compared to traditional teaching method on seventh grade students' retention of achievement on angles and polygons, and circle and cylinder when students gender, mathematics grade in previous year, the posttest scores on angles and polygons; and the circle and cylinder achievement tests, pre and posttest scores on van Hiele geometric thinking level test and mathematics and geometry attitude scales are controlled?

To compare the mean scores of each group on the delayed achievement tests (the DELAPA and the DELCCA), and to reveal whether the differences are significant or not while holding constant gender, and mathematics grade in previous year, the achievement posttests scores, pre and post test scores on the VHL, the MAS, and the GAS; another MANCOVA was conducted. According to the results of this MANCOVA, significant differences were found (λ = .829, p = .001) between groups on the collective dependent variables of delayed achievement tests. The results of this analysis appear in Table 5.17.

Table 5.17 Multivariate tests results for the MANCOVA comparing delayed posttest scores

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
Intercept	.629	23.335	2	79	.000	.371	1.000
Gender	.772	11.693	2	79	.000	.228	.993
MGP	.989	.429	2	79	.653	.011	.117
PREMAS	.995	.190	2	79	.827	.005	.079
PREGAS	.984	.649	2	79	.525	.016	.155

Table 5.17 (continued)

POSTVHL	.992	.303	2	79	.739	.008	.097
POSTMAS	.993	.263	2	79	.769	.007	.090
POSTGAS	.989	.446	2	79	.642	.011	.120
POSTAPA	.854	6.765	2	79	.002	.146	.909
POSTCCA	.672	19.295	2	79	.00	.328	1.000
MOT	.829	8.169	2	79	.001	.171	.953

To test the effect of the methods of teaching on each dependent variables of the DELAPA, the DELCCA, the ANCOVA was conducted as follow-up tests. The results of this analysis can be seen in Table 5.18.

Table 5.18 Tests of between-subjects effects

Source	DV	df	F	Sig.	Eta Squared	Observed Power
Corrected Model	DELAPA	10	21.486	.000	.747	1.000
	DELCCA	10	30.447	.000	.807	1.000
Intercept	DELAPA	1	44.360	.000	.357	1.000
	DELCCA	1	3.865	.053	.046	.493
GENDER	DELAPA	1	22.815	.000	.222	.997
	DELCCA	1	1.255	.266	.015	.198
MGP	DELAPA	1	.113	.738	.001	.063
	DELCCA	1	.731	.395	.009	.135
PREMAS	DELAPA	1	.368	.546	.005	.092
	DELCCA	1	.025	.875	.000	.053
PREGAS	DELAPA	1	.004	.953	.000	.050
	DELCCA	1	1.303	.257	.016	.204
POSTVHL	DELAPA	1	.032	.859	.000	.054
	DELCCA	1	.571	.452	.007	.116
POSTMAS	DELAPA	1	.472	.494	.006	.104
	DELCCA	1	.075	.785	.001	.058
POSTGAS	DELAPA	1	.101	.752	.001	.061
	DELCCA	1	.779	.380	.010	.141
POSTAPA	DELAPA	1	11.205	.001	.123	.911
	DELCCA	1	2.091	.152	.025	.298
POSTCCA	DELAPA	1	6.416	.013	.074	.706
	DELCCA	1	31.473	.000	.282	1.000
MOT	DELAPA	1	6.602	.012	.076	.719
	DELCCA	1	9.296	.003	.104	.854
Error	DELAPA	80				
	DELCCA	80				
Total	DELAPA	91				
	DELCCA	91				
Corrected Total	DELAPA	90				
	DELCCA	90				

As it is seen from the table, students taught by drama based instruction had higher scores on the DELAPA and the DELCCA than the students instructed by traditional method [F (1.80) = 6.602, p = .012 and F (1.80)= 9.296, p = .003 respectively].

5.2.5 Follow-up Analyses

In order to determine the unique importance of the dependent variables that were found to be significantly affected by the methods of teaching, step-down analyses were performed. With this analysis, any overlap between dependent variables is eliminated and absolute effect is revealed.

For the MANCOVA used for comparing the posttest scores, four step-down analyses were conducted. The previous analyses revealed that method of teaching has significant effect on the POSTAPA, the POSTCCA, the POSTVHL, the POSTMAS and the POSTGAS. Since the POSTAPA was administered three weeks before the other posttests, it is not possible that the POSTAPA results could be affected from the results of the other posttests. This means that there was no need to check the unique importance of the POSTAPA. Therefore except for the POSTAPA, four step-down analyses for the POSTCCA, the POSTVHL, the POSTMAS and the POSTGAS were conducted.

Results of the analysis when the POSTCCA was taken as the dependent variable of highest priority with the POSTAPA, the POSTVHL, the POSTMAS and the POSTGAS were taken as additional covariates appear in Table 5.19. According to the results, the effect of method of teaching had still significant effect on the POSTCCA [F (1.91)= 25.339, p= .000]. This implies that after accounting its effect on angles and polygons achievement, Van Hiele geometric thinking level, mathematics and geometry attitude, the effect of drama based instruction on students' circle and cylinder achievement was still significant.

Table 5.19 Step-down ANCOVA for the POSTCCA

Source	df	Mean Square	Step-down F	Sig.
POSTMAS	1	4.948	.203	.653
POSTGAS	1	22.741	.934	.336
POSTVHL	1	16.856	.692	.407
POSTAPA	1	406.675	16.706	.000
MOT	1	616.816	25.339	.000

With the purpose of assessing the effect of the method of teaching on POSTVHL beyond its effect on the POSTAPA, the POSTCCA, the POSTMAS and the POSTGAS, another step-down analysis was conducted. The results appear in Table 5.20. According to the results, the effect of method of teaching had still significant effect on the POSTVHL [F (1,91)= 4.352, p= .040]. This indicates that the effect of drama based instruction was significant on students' Van Hiele geometric thinking level, after accounting its effect on angles and polygons achievement, mathematics and geometry attitude.

Table 5.20 Step-down ANCOVA for the POSTVHL

Source	df	Mean Square	Step-down F	Sig.
POSTAPA	1	2.388E-03	0.002	.965
POSTCCA	1	2.420E-02	0.020	.888
POSTMAS	1	.342	0.283	.596
POSTGAS	1	.547	0.453	.503
MOT	1	5.258	4.352	.040

The results of the step-down analysis when the POSTMAS was taken as the dependent variable of highest priority and the POSTAPA, the POSTVHL, the POSTCCA and the POSTGAS were as additional covariates are presented in Table 5.21. The results showed that, the method of teaching had not significant effect on the POSTMAS [F (1.91) = 3.770. p= .055]. This implies that the analysis failed to detect a significant difference on mathematics attitude score between groups, after accounting the effect of method on angles and polygons; and circle and cylinder achievement, Van Hiele geometric thinking level and geometry attitude.

Table 5.21 Step-down ANCOVA for the POSTMAS

Source	df	Mean Square	Step-down F	Sig.
POSTGAS	1	5542.848	22.416	.000
POSTVHL	1	4.787	0.019	.890
POSTAPA	1	103.899	0.420	.518
POSTCCA	1	46.304	0.187	.666
MOT	1	932.282	3.770	.055

Table 5.22 shows the result of the step-down analysis, when the POSTGAS was taken as the dependent variable of highest priority and the POSTAPA, the POSTCCA, the POSTVHL and the POSTMAS were taken as additional covariates. As seen in table, the POSTGAS had not been significantly affected of method of teaching [F (1.91) = .310, p= .579]. This implies that after accounting its effect on angles and polygons; circle and cylinder achievement, Van Hiele geometric thinking level and mathematics attitude, the effect of drama based instruction on students' geometry attitude was not significant.

Table 5.22 Step-down ANCOVA for the POSTGAS

Source	df	Mean Square	F	Sig.
POSTAPA	1	2.084E-04	0.000	.999
POSTCCA	1	569.785	5.032	.027
POSTVHL	1	47.632	0.421	.518
POSTMAS	1	2950.669	26.059	.000
MOT	1	35.062	0.310	.579

For the MANCOVA used for comparing the delayed posttest scores, two step-down analyses were conducted as the previous analyses revealed that method of teaching has significant effect on both the DELAPA and the DELCCA.

Result of the analysis when the DELAPA was taken as the dependent variable of highest priority with the DELCCA was taken as additional covariates is presented in Table 5.23. According to the results, the effect of method of teaching had still significant effect on the DELAPA [F (1.79)= 6.413. p= .013]. In other words, after accounting its effect on retention of circle and cylinder achievement, the effect of drama based instruction has still significant effect on retention of angles and polygons achievement.

Table 5.23 Step-down ANCOVA for the DELAPA

Source	df	Mean Square	Step-down F	Sig.
DELCCA	1	70.551	0.124	.725
MOT	1	3635.138	6.413	.013

Result of the analysis when the DELCCA was taken as the dependent variable of highest priority with the DELAPA was taken as additional covariates is provided in Table 5.24. According to the results, the effect of method of teaching had still significant effect on the DELCCA [F (1,79)= 9,071, p= .003]. This implies that after accounting its effect on retention of angles and polygons achievement, the effect of drama based instruction has still significant effect on retention of circle and cylinder achievement.

Table 5.24 Step-down ANCOVA for the DELCCA

Source	df	Mean Square	Step-down F	Sig.
DELAPA	1	4.135	0.124	.725
MOT	1	301.315	9.071	.003

5.3 Qualitative Results

The following excerpts from the interview responses can be seen in Turkish in Appendix N. They can be followed with codes, involving the numbers and letters, given in parentheses at the end of each excerpt. For example, in the code (10-S12), 10 was used to indicate the tenth excerpt and S12 indicated the quote of the student 12.

5.3.1 Students' Opinions related to the Effect of Drama Based Instruction on Their Learning

In order to the get the EG students' opinions related to the effect of drama based instruction on their learning, they were asked the question of "Does drama affect your learning? How? "

All the students from the EG stated that drama based instruction provided them to learn easily and understand better. The reasons they mentioned vary in a numerous ways.

Some students reported that improvisation of daily life examples affected their learning positively. Real life examples were easier, more logical, interesting, and familiar for them. They acquire knowledge as well as a sense of when and how to use it, since the knowledge was given in a meaningful context, rather than abstract learning out of context. By this way students felt the importance of geometry and understood when to use it as they stated. Dealing with the authentic situation instead of routine problems took their attentions and helped them to concentrate on the topic. They also stated that they had fun with the daily life examples. With the help of daily life examples students realized the connections between the life and mathematics. They mentioned benefits of real life examples as follows:

> We were scouts in the lesson. The scouts tried to find a way to get equal heat around the fire. When we formed a perfect circle, we saw that all of us could get heat. The center was the fire. For example when a tree felt down, it was tangent or chord… etc… Drama is the activity to make geometry easier. For example in scouting camp, we defined center as a fireplace, then located around the center to get heat. By this way a circle was formed, we learned the central angle like this. Briefly, drama is a work to make a difficult lesson easier (1-S1).
>
> Drama is a part of life; it is just like real life. Our roles are from real life. For example Spider Man. We already know him from TV. It was just like we got a letter from the real Spider Man. And the scouts are from real life. Anyway, scouts are gathering around a fire neatly in real life (2-S2).
>
> Drama made me understand better, made me concentrate on the topics. Since mathematics is difficult, I could not concentrate easily in the past. But daily life examples provided me to connect with the lesson (3-S3).
>
> Since we learned from daily life, it was fun. Since it was fun, I understood better. It provided me learn better (4-S4).
>
> I had more fun with daily examples... It was also more logical with the daily life examples… Scouts or the daily life examples made it easily understandable… Drama took our attention, for example we thought scouts do like that and it took our attention (5-S6).
>
> Since natural examples like camping scouts, trees etc., were given, we comprehended better (6-S7).
>
> Carton characters, letters, ropes, etc. all were from our life. We understand that mathematics is connected to our life (7-S8).

> It made learning easier. When we learnt with Spiderman etc., it was like a play, so we learnt more easily… When I was a scout in the circle, I understood central angle and inscribed angle. Scouts affected my learning (8-S9).
>
> Examples were from our environment. We know all of them already and we wanted to pay attention to them, we wanted to use our brains…. While studying the situations from real life, we understood when it is useful. When I look outside now, geometric shapes are formed in my mind. It is a good way to learn. I wish that mathematics would be always instructed like that. Because when it is from daily life, it is more fun and we are interested in much more and participate more. Because we know something about daily life, we can compare with daily life (9-S10).
>
> Since it was from daily life, it was familiar to us. We live it in our life. This makes it easy... We understood when it is necessary (10-S12).

Improvisation of the daily life situations by the students made what they have learnt more permanent. They can easily retrieve what they have learned by imagining of what they have done in the classroom. They stated that since they have learned the reasons behind what they have learned, their learning was more meaningful for them. Knowledge situated within the practices of the real life, rather than something which the teacher said or exists out there in books, provided them meaningful learning. Meaningful learning was also provided by participating actively like seeing, doing and discovering. It is long lasting as they stated. They cited that they did not have to memorize what they have learned. They could easily remember what they have learned when they think of the classroom activities. This implied that they understood that mathematics is not simply memorizing rules furthermore it should make sense and be logical. In addition students also mentioned about the activities provided them to recall their existing knowledge. Here are some examples of their statements.

> For example in the exam, I can easily remember what we did in the lesson and solve the questions. What we did in the lesson is more permanent for me (11-S1).

Since we saw what we learned, it is more permanent. We were not just writing, we saw what we learned which makes it more permanent. Seeing and doing are always better. They make learning more permanent (12-S2).

We learned what is what. Since we tried to find truth ourselves, we can keep it in our mind. For example, you didn't give us the value of π. We found its value by ourselves. You gave us several objects, we saw them and measured them, and then we reached a mathematical conclusion. We found which numbers make a triangle, which numbers does not make triangle [by the "numbers" she meant the sides length of a triangle]. Because of that, we comprehended better and they all will stay in our mind in our life time (13-S3).

What we did in the lessons will stay permanently in our minds. We will never forget the activities with Spider Man (14-S5).

By doing drama, what we did remain in our minds. We remember everything now. We think, "I did that activity and I remember now "(15-S6).

When you find and discover yourself, you learn more and better... You remember your previous knowledge and refresh your mind. In this way you learn more. Since you [we] were in the activity, you [we] understood better. By this way I realized that I could do it consciously, with understanding. Your knowledge gets stronger, when you (we) do it consciously. This makes it permanent. For example no one will ask the interior angles of triangle but we can solve the life problems with the help of this knowledge (16-S8).

We learned the fundamentals of geometry, that is we understood reasons of everything. If we had just learned the central angle.. Which one is central angle? What is central angle? ... It is not easily learned like that, but we were scouts. How scouts can get heat? How scouts can deal with the fire? We learned all of them by drama method. If we hadn't learned by drama method, they would have come and gone. We would never remember (17-S9).

Since we learned by seeing, it was not memorization and more permanent. This made me understand more and saved me from memorizing. I began to love geometry (18-S11).

For example, we formed the shape by using our bodies. By this way we saw how it is formed. If we memorized, we could easily forget it in a short time. But if you learn, you cannot forget. It makes more permanent (19-S12).

There was a considerable emphasis on visualization provided by drama. Students stated that it affected their learning, as visualization made them to convince what they are learning is true. That is, visualization is a kind of proof for them. Visualization also saved them from memorizing and it can be reckoned as a reason for providing permanent learning. Furthermore, student responses included that visualization creates an interest to the lesson.

It was not memorizing. It was visual. By this way I learned easier (20-S1).

When you see with your eyes, it is more effective. Since we saw what we done in the classroom, we learned better (21-S2).

In the past mathematics was just an explanation. There was no visualization. Formerly I thought that, there was nothing visual in mathematics. But in these lessons, I saw that. People think that education should be visual and based on experiments. Drama provides this... For example the way we found the value of π, angles, triangles etc., how a triangle can be constructed, whether it is constructed or not. We saw lots of things. We will remember what we learn in our lifetime. Since we learned by seeing, it is more permanent for us (22-S3).

When we saw visually, we were more interested in and easily caught the crucial points. We will solve the life problems we will face in future by the help of it (23-S8).

We learned by seeing, it was far more just memorizing (24-S11).

Some students mentioned that working as groups affected their learning. Their responses demonstrated that group works facilitated them to learn the responsibility and provided motivation to learn. The social interaction between the students assisted the construction of knowledge. Working in groups enabled them to acquire knowledge by seeing others' behaviors, receiving different ideas, understanding others points of view. They helped to each other, by this way learned from each other. They claimed that teaching each other provided them learn better.

> Everything was done as groups. When we were working in groups, we were pleased to work in groups. We felt we can do (25-S1).
>
> We only wrote in notebooks in the past, we are now discussing together (26-S3).
>
> For example when you gave us envelopes, straws and ropes, we have to work together. The activities taught us cooperation. In this way, we had more fun and the possibility of making wrong decreased. Also we got motivated (27-S4).
>
> We learned to work together. Everyone in a group had a duty, so that we have learned responsibility (28-S7).
>
> Everybody was helping each other. The lessons were like games. I taught my friend something and they taught something to me, too. We transferred knowledge to each other… You [we] were also observing the others while you [we] were doing in the lesson. By this way we have learned (29-S9).
>
> We worked together, helped each other. We asked each other when we did not understand something.... We were expressing ideas, discussing with our friends, and getting their ideas, so that our friendship grew (30-S10).
>
> We worked together; one completed what another missed (31-S11).

Some students' responses revealed that the excitement they felt during the drama based activities has also affected their learning. As they mentioned, they particularly had fun with the music, daily life examples, role taking, learning by doing and not be forced to memorize the facts. Exciting and interesting classroom environment took their attention and provided them learn better. They mentioned some reasons of that as followings:

> Geometry was fun with music in the classroom (32-S1).
>
> Absolutely, it was more fun. For example constructing geometric shapes by our hands, arms and ropes was enjoyful. Drawing the shapes by our shoulders, elbows, and nose was enjoyful. When it is enjoyable, we understand better. Examples from actual life like scouts, rockets of NASA

> attracted my attention… also related with the things we wanted to learn like Spiderman. They made it enjoyful. They were like stories; they were like the games we played in our childhood (33-S4).
>
> I wrote on the paper [she meant the geometry attitude scale administered before the treatment] that I did not like geometry, but it changed. It was enjoyful. We were interested in learning when it is with drama (34-S5).
>
> It was more fun with improvisation and forming the shapes by our bodies and other material (35-S7).
>
> Standing and walking in the classroom, seeing the others, and even knowing that "everybody in the classroom is seeing me" were entertaining. Participating enjoyed me…you [we] had fun since you [we] saw it from child perspective (36-S8).
>
> It was entertaining. We learnt what we were learning, improvised something. These made the learning enjoyful… We did not understand how the time past (37-S9).
>
> Geometry was more fun and easier. With the examples from life, it was more enjoyful (38-S10).
>
> Since it was not memorizing, I liked it more (39-S11).
>
> Drama was fun and lessons were like enjoyful game for me..... When we were scouts, the topics were more enjoyful for me and I understood more (40-S13).

In order to get the EG students' views related with the negative aspects of drama based instruction on their learning; they were asked "Is there any negative effects of drama on your learning?"

Of the interviewees, six of them expressed that there is no negative point for them. On the contrary, five students complained about the noise in the classroom. They suggested that the teacher must be controller like punishing or scolding.

> In the lesson, the talks of our friends lessened our understanding. If there had been 20 students instead of 34, the discipline problem could have

been solved since there would be less students' talking. Sometimes they thought that we were just playing games (41-S3).

If everyone had paid more attention, it would have been better. There was a buzzing in the classroom (42-S6).

In drama everybody was talking, just like we were not in the lesson. If teacher had scolded them, it would be better (43-S11).

We were in a relaxed mood. In this way we lose something about management. In my opinion, some of our friends should have been punished (44-S12).

Students talked too much. Even if they were related with the lesson, noise is not a good thing (45-S13).

A students stated that he wished solve more questions in the classroom. Direct information giving has the advantage of allowing the teacher to cover a great deal of topic quickly, to control subject matter being learned, to make sure it is correct and to solve questions. Since discovery and construction of the knowledge by the students took time in drama activities, there was little time to solve questions.

We did not solve many problems (46-S5).

5.3.2 Students' Opinions related to the Effects of Drama Based Instruction on Their Friendship Relations

In order to get the EG students' opinions about the effects of drama based lesson on friendship relations they were asked "Do you think, what was done during these units have affected friendship relations in class? If yes, in what way? (Your relation with your friends or relation between others based on your observation) ".

All the students, except for one student (S11), thought that the friendship relation was affected positively. Students mentioned that drama based instruction provided them to be closer to the other students by forcing them to work with the other students. Working with others brought them to ask for help; discuss, and share the ideas, i.e. communicate with other students. While working in groups, they had to forget their past arguments with their friends. By the activities they also had the opportunity to see good characteristics of the other students. As they said, they had a chance to know their friends. On the other hand, S11 stated that friendships did not change.

> Since we concentrated on the same issues, we forgot about our past quarrels with some friends and our relations got better. For example, while studying with the straws and ropes, we were talking with our friends. We discussed about our ideas with our friends, our thinking developed (47-S2).

> In order to learn something we had to work together. Circumstances required us to get closer. Because of that, we got closer... I am closer to my friend, now. I become close to some of my friends with whom I did not have any relation before that. It helped me in my friendship relations (48-S3).

> I have learned that I can learn better when I study with my friends. I know that, it is better to study with them from now on. We learned about our friends. For example, Student X had been very isolated person, however when we worked together with him, I realized that he was not a bad person. Then we got closer (49-S5).

> I made a relation with some friends to whom we never do anything. We got closer (50-S6).

> While we were working together, we said the same idea at the same time, we agreed on something. This made a connection between friends. We found common points so that we got closer(51-S8).

> We worked together, helped each other. We asked them when we did not know something. We were expressing ideas, discussing with our friends, and getting their ideas, so that our friendship grew (52-S10).

> We were trying something with the friends even we weren't close before (53-S12).

> I got closer with a friend with whom I had not even talked before. For example after we made measuring with Student x we get closer... In the past I never asked my friends about the questions I could not solve but now I can easily go and ask them (54-S13).

5.3.3 Students' Opinions about the Effects of Drama Based Instruction on Their Awareness of Themselves

To the get the EG students' opinions related with drama based instruction on their awareness of themwelves, they were asked the question of "During these lessons, have you learned something new about yourself? Do you realize any feature of yourself, you have never recognized before?"

All students from the EG, except two (S7, S11), stated that they learned something about themselves during the drama based lessons. Students felt and realized their individual talents and their own characteristics they were not aware before. Expressing their insights during the drama activities was helpful to demonstrate their potentials. Some students claimed that they realized their intelligence, and ability to succeed in mathematics, to create something, and to teach their friends. Furthermore, a student stated that she realized that she could learn better while working with others. As they learned more about themselves, they gained confidence in themselves. The following quotes were from the students' responses to this question.

> In the past I did not like speaking, but in these lessons, I talked pretty much. I realized that I participated to lesson more than past. I did not know that I am that much clever. I discovered my intelligence. When I know something, I think that I am intelligent (55-S1).
>
> I created something by myself. I realized that I could produce something new (56-S3).
>
> I learned that I could easily understand with drama. I recognized that when I work with the friends I learn better and I can teach something to my friends (57-S5).
>
> I found out that I can teach my friends (58-S10).

Some students mentioned that they realized their potentials of being successful in mathematics. The following quotes can exemplify their ideas about that.

> I was not good at mathematics in past years. I am good at mathematics this year than past. I got to know myself. I think that "I am good at mathematics, I can study on mathematics in future"....For example, I could

not do geometry in the past. But now I can do that. I got to know myself. I really did not know these characteristics of mine. I did not know that I like geometry that much (59-S2).

I realized that geometry is fun and I can solve even difficult geometry problems. In the past, I demoralized and got angry when I studied geometry, but now it is very interesting and like it (60-S9).

I thought that I could not solve mathematics problem and I never succeed in mathematics. But in drama I have done something. I can tell my opinions without fear of teacher. Now, I believe that I have the ability to succeed in mathematics (61-S13).

Learning about themselves provided them to gain confidence about themselves as they stated. Without a fear of making mistakes, they felt more confident in their actions. Since they were active in the lesson, talked and did something related with mathematics, they felt their ability in mathematics. This might also bring the confidence.

I learned that I could rely on myself when I learn something new (62-S4).

I found out that I could do everything if I wish (63-S6).

Before that, I have no confidence in myself. As I was doing and participating in the lessons, I felt confidence in myself on mathematics and geometry. When I feel confidence in myself, I am happy (64-S8).

I realized that I could understand something by myself, without someone explains to me (65-S10).

5.3.4 Students' Opinions related to the Role of Students in Drama Based Instruction Environment

In order to the get the EG students opinions related to the role os students in drama based instruction, they were asked the question of "Do you think, in these lessons have the role of students changed? Can you compare the role of the students in these lessons with the role of the students in the other lessons?"

Generally, students emphasized that they were more active by physically and cognitively in these lessons. They mentioned their participation by measuring, forming, discussing, thinking, helping, doing, explaining, and improvising, etc., and the benefits of this participation like learning better, remembering longer, and enjoying more. They stated that they worked together as a group instead of work alone. When we looked at the students responses, they particularly emphasized that, everyone in the classroom participated the lessons.

> Everybody was trying to do something. For example we were working with straws in groups, we altogether found whether a triangle can be constructed or not, we were measuring the perimeter of a lid, our friends was calculating by dividing the perimeter to diameter. Everybody did something. The teacher just wrote the answers (66-S12).
>
> Now, everybody participated actively without any fear (67-S2)
>
> In the past, the teacher asked us. But now, we do it. In the past, we wrote and answered the questions. Now we do drama and we understand better (68-S4).
>
> In drama, we have to participate. By this way our friends who don't study much had to participate to the lesson. For example, even Student x, Student y, Student z, and Student w [She gave the name of 4 students] made angles for us. This was fun for them. They had a chance to understand better (69-S5).
>
> According to my observations, the student who had not participated to lesson now participating the activities. For example, I participated more than I did. Even the spoilt friends participated more. Everyone raised his or her hands to participate and say something (70-S6).
>
> For example, we were measuring, forming shapes like triangles and quadrilaterals, cooperatively (71-S7).
>
> In the past we had just answered teacher's questions, but now we are explaining the topics. We are in the lesson. Just like, we are giving the lecture. We are doing, writing on the board, explaining, and improvising. As if we took the role of teacher (72-S8).
>
> In the past we were busy with something not related with the lesson, now we are working related with the lesson. Everyone works with others, transfers opinions and thoughts (73-S9).

Drama based activities brought the necessities of communication. Engaging in discussion and negotiation within or between groups in all phases of the lesson brings some advantages. While the students were preparing an improvisation in their groups for example, they had to exchange their ideas, criticize others' ideas, and negotiate on their roles and presentation. Moreover, in order to remove a conflict posed by the dramatic moments, they were suggested solutions, discussed similarities and differences of all suggested solutions, criticized the others solution, justifyed and tried to convincing others to their own solution. Students become consciously aware of what they were studying on. They reflected and clarified on their thinking about mathematical ideas and situations. By this way, a concept at an intuitive level have became at reflective level.

> In the past, we wrote our notebooks in our desks. Now we are talking since the teacher keeps asking questions. We are discussing related with the topics, in order to answer the questions and solve the problems… When we were doing, everyone could freely express his or her ideas. We were happy when we found the things and expressed our ideas. Everyone explained their opinion, discussed something even in breaks (74-S1).
>
> For example, while studying with the straws and ropes, we were talking with our friends. We discussed about it, our thinking developed. This made me learn better (75-S2).
>
> While everyone worked alone in the past, we were now discussing together. We concentrated on some issues and talked about them. We could explain our opinions freely (76-S3).
>
> In lessons we had to explain something. Participation and expression of ideas were necessary in every lesson (77-S7).
>
> Students were listening to what teacher explained in the past, but now students are explaining in a way (78-S11).

In the previous lessons, writing the rules with little or no meaning attached was boring for the students as they stated. When they compared the drama based lesson with the regular lesson, they articulated that the latter was more dull for them by stating "sitting boringly", and "sitting like sleeping". Since it is meaningless to the students, it is also harder for them. Drama based instruction provided with them understand the topic through an enthusiastic engagement. The following excerpts revealed that the students were cognitively active in drama based lessons.

> In the past, class had been writing boringly. Since mathematics is difficult, our friends had not liked it. Because they could not do it. But now, everybody participated actively without any fear. Now with questions, the brains woke up and thought about I can solve it (79-S2).
>
> In lessons we had to explain something, participation is necessary in every lesson. We participated to activities, instead of sat down and wrote. We used our brains. We added something to lesson (80-S7).
>
> We connected to the lesson. We liked it. We participated and had to think about the lesson. We had to use our mind (81-S10).
>
> Students were sitting like sleeping in the desks. Now students are working together and eagerly raising their hands (82-S13).

Two of the students mentioned that they felt that they were more free in the classroom.

> We were more relaxed in the classroom (83-S12).

Students were free to walk in the classroom. We are more free now (84-S13).

5.3.5 Students' Opinions related to the Role of Teacher in Drama Based Instruction Environment

In order to the get the EG students' opinions related to the role of teacher in drama based instruction, they were asked the question of "Do you think, in these lessons have the role of teacher changed? Can you compare the role of the teacher in these lessons with the role of the teachers in the other lessons?"

Students stated that the teacher's role has changed from knowledge transmitters to facilitators of learning by creating group work environments, encouraging communication, questioning, and giving clues. As they stated, teacher did not explain the topics. Instead of that the students explained the topic. According to them teacher asked them questions to make them express their opinions. The students more involved with the learning process than in a traditional classroom and offered more control over the content, direction and method of learning.

> Normally, teacher wrote something on the board then we wrote them to our notebooks. It had been boring. The effects of teacher have decreased, she always asked to us, didn't give the answer first. Now, we are trying to do ourselves, the correct things from our works were written on the board. Teacher made the geometry like a game, made it simple (85-S1).
>
> In the past, something was written on the board. It was boring. But now, teacher asked more questions, and gave clues. But in these lessons, our brains developed. We progressed in a logical way (86-S2).
>
> Teacher did not explain the topics first just like real teacher. We did something, she directed us, gave clues… It provided that we could say our opinions. We can freely express our ideas because teacher asked that. We refreshed our knowledge by this way (87-S3).
>
> Teacher directly explained the topics in the past, solved examples, did not ask much questions. It had not been enjoyful. When it is enjoyful, it is more understandable for me (88-S4).
>
> The teacher showed us the way, did not explain much (89-S6).
>
> The teacher wanted us to explain something, made us to improvise something so that we could understand better (90-S7).
>
> Teacher explained in the past and gone. We were not interested in that way. Teacher gave more examples about our environment now. This makes the lesson interesting to me. Generally, she did not explain the topic, she asked, we found it (91-S10).
>
> The teacher explained the topics in the past, we are explaining now. We learned by discussing in groups. We helped the teacher on explanation of the topics (92-S11).
>
> Teacher had explained the topics in the past. But now we worked in groups. The teacher also had fun in the lesson. I understood it from her smile (93-S13).

Since the teacher took roles in some lessons and gave clues to the students, some students perceived teacher as their friends.

> We felt that teacher was closer to us. We began to see teacher as a friend. For example she was also a scout leader or another thing in drama. For example she brought the letters from Spiderman. I thought that she was not a real teacher but a friend of us (94-S5).
>
> We were comfortable; the teacher did not scold when you said the wrong things. The teacher became our friends our elder sister (95-S12).

5.3.6 Classroom Teacher's Opinions about the Drama Based Instruction

The following excerpts from the responses of the teacher, who was present in EG during the treatment, in the interview can be seen in Turkish in Appendix O. They can be followed with the numbers given in parentheses at the end of each excerpt.

In order to get the classroom teacher's views related with the positive aspects of drama based instruction she was asked, "What are the positive aspects of drama based instruction?"

The classroom teacher pointed out that the students got the chance to express and criticize their ideas. She stated that drama based instruction took students attention by giving them the opportunity to express their ideas. Students' engagement by talking made the other students pay attention to the lesson.

> They (students) had the opportunities to express their ideas. They criticized their friends' ideas. We do not do that in regular lessons. We do not give students opportunity to talk. Even if we gave them opportunity to express themselves, students would not take it serious. So we have changed the way, and we explain the topic by ourselves. In these lessons, students are shy at first. But when you gave students opportunity to talk, even the most unrelated student paid attention to the lesson. Students think that, our friends were speaking, they were telling something.

Therefore, the students tried to understand what was going on in the classroom (1).

She also mentioned the permanent learning provided by the drama based instruction. She implied that by remembering the interesting activities they have done in the classroom, students could easily retrieve the geometry topics they have learned.

.... These activities [drama based activities] were more permanent for the students. When students remember the exciting and interesting things they did in the classroom, they will remember the geometry topic (2).

Classroom teacher mentioned the group works as a positive aspect of drama based instruction. She affirmed that by working in groups, students learned from each other and taught something to each other.

Students learned by working as a group. Normally, we cannot let them work in groups... Group works made them to learn to work with their friends, learn from their friends and teach something to their friends (3).

Classroom teacher also mentioned positive effects of drama based instruction on students' affective characteristics. She emphasized that drama based instruction foster students imagination, creativity, and confidence in themselves.

I think that, it (drama based instruction) improved the students imagination and creativity... They became to feel confidence in themselves. As they participated to the lesson, they understood that they could participate to the lesson, and they could be successful. Even the students, who were unsuccessful in the past, participated to the lesson (4).

Classroom teacher also stated that drama based activities were very interesting, motivating and exciting to the students. Because of those characteristics, they paid attention to the lesson

The topics were presented in an interesting way. The lesson became exciting for the students, and motivated them. So their attention was on the subject steadily. Since the lesson was more interesting to them, they

> understood more. It provided that they like mathematics more. It was beneficial in that respect. Students' minds had to be busy with lesson (5).

In order to get the classroom teacher's views related with the negative aspects of drama based instruction she was asked "What are the negative aspects of drama based instruction?"

The classroom teacher mentioned about the preparation of the lessons plans, materials etc. before the lesson. She claimed that implementation of drama based activities brings some burden to the teacher as preparing lesson needs creativity, patience, time, and money. She pointed out that, a regular classroom teacher giving seven hours lesson a day cannot manage to do these.

> They were very good activities, I am very positive for them, but they require much patience. Some materials should be prepared for every lesson. For example, you brought some material in every lesson; cylinder, flashlight, rope, scissors, papers, pictures, etc. Teacher has to prepare them or buy them. They are both endeavoring, time consuming and costly. For example, a teacher with seven hour lesson a day, cannot prepare the lesson that much. In addition to that, the lesson should be planned. For example, scouts, plays, etc. In order to plan them, you have to be creative. Each teacher cannot prepare his/her lesson like this (6).

Teacher also mentioned about the changes in the arrangement of the classroom. These necessary changes for the drama based activities must be done in the recess and bring another work to the teacher. The teacher implied that teachers cannot do that and suggested that teacher can make the students to do that.

> Regular classroom arrangement is not appropriate to do drama based activities. You made some arrangement on the desks prior to each lesson. But the teachers cannot do that before every lesson. The recess belongs to teachers. We need to rest in 5 minutes. We are very tried with the engagements of students or administration. Because of that we cannot deal with the organization of the classroom. Or you can make the students to do that. You can give charge to the students (7).

The classroom teacher stated that in drama based instruction fewer questions can be solved because of time constraints. She complained about the load of the mathematics curriculum and emphasized that in a mathematics lesson much more questions should be solved.

> You did not solve many questions at the end of the activities. In order to strengthen the understanding of the topics, we need to solve plenty of questions. Mathematics is different than the Turkish lessons or science lessons. When you do drama activities, you do not have time to solve questions. Our curriculum has too much topics. If the instruction is like this, you cannot solve questions. If you solve questions after these activities you cannot complete the curriculum (8).

The teacher summarized her responses to this question by stressing the burden drama based instruction brings.

> Briefly the most negative part is that the bigger duty for the teacher than today; arranging the classroom, preparing lessons plans that can attract the attention of the students, making or finding some materials. If these types of activities were more common, we were given the materials and lesson plans, we could instruct like this. But now, we need resources (9).

In order to get the classroom teachers' views about drama based instruction she was asked, "What are your suggestions about the drama based instruction?"

The teacher suggested that drama based instruction should be used in the class with smaller number of students.

> It would be easier to use this method in the class with fewer students (10).

Another suggestion of the classroom teacher is that drama based instruction should be used in more successful classroom. She justified her suggestion as follows:

> I think that, drama based instruction should be used in good class. If students are successful, they will participate more, they will think well, they will answer better, and they will ask good questions. It should be

implemented the students with potentials. If the students are not successful, we should solve more questions (11).

5.4 Summary of the Results

5.4.1 Summary of the Results related with Quantitative Research Questions

Drama based instruction had a significant positive effect on students' angles and polygons achievement, circle and cylinder achievement, Van Hiele geometric thinking level, mathematics attitude, and geometry attitude compared to the traditional teaching.

The effect of drama based instruction on students' angles and polygons achievement was still significant, after accounting its effect on circle and cylinder achievement, Van Hiele geometric thinking level, and mathematics and geometry attitude. The effect of drama based instruction on students' circle and cylinder achievement was still significant, after accounting its effect on angles and polygons achievement, Van Hiele geometric thinking level, and mathematics and geometry attitude.

Students' Van Hiele geometric thinking level was significantly and uniquely affected by drama based instruction after accounting its effect on angles and polygons, circle and cylinder achievement, mathematics and geometry attitude.

The effect of drama based instruction on students' mathematics attitude was not significant after accounting its effect on angles and polygons; and circle, cylinder achievement, van Hiele geometric thinking level and geometry attitude. Similarly, the effect of drama based instruction on students' geometry attitude was not significant, after accounting its effect on angles and polygons; and circle, cylinder achievement, van Hiele geometric thinking level and mathematics attitude.

Drama based instruction was effective on students' retention on angles and polygons; and circle and cylinder achievement. The effect of drama based instruction had still significant effect on retention of angles and polygons achievement, after accounting its effect on retention of circle and cylinder achievement. After accounting its effect on retention of angles and polygons achievement, the effect of drama based instruction had still significant effect on retention of circle and cylinder achievement.

5.4.2 Summary of the Results related with Qualitative Research Questions

Students opinions related with the effect of drama based instruction on their learning were very positive. Students stated that drama provided them to learn easily and understand better. Improvisation of daily life examples affected their learning positively since they were easier, more logical, interesting, and familiar for them and made them realize that the connections between the life and mathematics with the help of daily life context. Students also stated that drama based lessons provided with permanent learning since it was more meaningful for them. Another point related with the affects of drama on the learning is visualization which is not only a kind of proof for them but also saved them from memorizing and it can be reckoned as reason for providing permanent learning. Students also mentioned that working as groups affected their learning. Group works facilitated them to learn the responsibility, provided motivation to learn and enabled them to acquire knowledge by seeing others' behaviors, receiving different ideas, understanding others' points of view. Students also emphasized that the excitement they felt during the drama based activities has also affected their learning. Exciting and interesting classroom environment took their attention and provided them learn better. Students stated that working with others brought them to ask for help, discuss, and share the ideas. They had a chance to know their friends. Drama based instruction provided them to be closer to the other students by forcing them to work with the other students.

Students claimed that they learned something about themselves during the drama based lessons. They felt and realized their individual talents and their own characteristics which they were not aware before. Learning about themselves provided them to gain confidence about themselves as they stated.

Concerning with the role of the teacher, students stated that the teacher role is changed from knowledge transmitters to facilitators of learning by creating group work environments, encouraging communication, questioning, and giving clues. Since the teacher took roles in some lessons and gave clues to the students, some students perceived teacher as their friends.

Five students complained about the noise in the classroom. They suggested that the teacher must be controller like punishing or scolding. A students stated that he wished solve more questions in the classroom.

The classroom teacher pointed out that the students got the opportunity to express their ideas, criticize others' ideas. She mentioned that drama based instruction provides permanent learning, gets attention of the students, and fosters students imagination, creativity, and confidence in themselves. She also mentioned the group works as positive aspects of drama based instruction. Classroom teacher also stated that drama based activities were very interesting, motivating and exciting to the students.

For the negative aspects of drama based instruction, the teacher emphasized the burden drama based instruction bring to the teacher like preparing the lessons plans and materials, arranging the classroom environment. Another negative point for her was the number of questions solved related with the topics. As she stated more questions should be solved. The teacher suggested that drama based instruction should be used in the class with smaller number of students and used in more successful classroom.

CHAPTER 6

DISCUSSION, CONCLUSIONS AND IMPLICATIONS

This chapter consists of four sections. First section presents the discussion of the results. The conclusions are given in the second section. Implications and recommendations for further studies are given in the third and fourth sections respectively.

6.1 Discussion

The aims of this study were to investigate the effects of the drama based instruction on seventh grade students' achievement on geometry (angles and polygons; circle and cylinder), retention of achievement, van Hiele geometric thinking level, attitudes toward mathematics and geometry compared to the traditional teaching; to get the students' views related to the effects of drama based instruction on their learning, friendship relations, awareness of themselves, and the role of teacher and students; and to get the teacher's views on drama based instruction.

Findings of the study confirm that the drama based instruction has a significant effect on students' angles and polygons; and circle and cylinder achievement compared to the traditional teaching. Adjusted R^2 for the posttest scores of angles and polygons achievement test, and circle and cylinder achievement test revealed as .563 and .675, respectively. The calculated large effect sizes (1.288 and 2.076 for the posttest scores of angles and polygons achievement test, and circle and cylinder achievement test, respectively) claim the practical significance of this result. Also the MANCOVA calculated the power of the analysis for the comparing the posttest results as 1.00 that was higher than the preset value. At the beginning of the study, the power of the study calculated as between .95 and .99 for this analysis.

This finding of the study related with achievement supports the findings of previous studies (Omniewski 1999; Saab, 1987), which provided evidence to show the efficiency of drama based instruction in facilitating an explicit understanding of mathematics concepts. The findings also agrees with the findings of effectiveness of drama based instruction on the second graders' achievement on life sciences (Üstündağ, 1988), eight graders' achievement on basic rights and duties in liberal democracy (Üstündağ, 1997), third graders' achievement on English as a foreign language (Aynal, 1989), third graders' achievement on standardized proficiency test (Barnes, 1998a), the fifth-graders' reading achievement (Dupont, 1989), elementary graders' science achievement (Kamen, 1992), and high achieving science and mathematics students' science achievement (Kase-Polisini & Spector, 1992).

Several reasons may account for the positive effects of drama based instruction on achievement. Visualization provided by drama based instruction improved the EG students' geometry achievement. Students indicated that visualization is a kind of proof for them. Previous researchers stated that visualization is the core part of geometry (Battista, 1994; Bishop, 1989; Hershkowitz, 1989) and many students use visual imaginary to reason about the figures (Battista & Clements, 1999). Visualization provides a basis for assimilating abstract geometric knowledge and individual concepts (Yakimanskaya, 1971). By this way, it keeps students from memorizing and provides them some pictures in their mind to remember and retrieve the facts in future. Moreover, visualization is helpful in developing the students' appreciation of the beauty of mathematics and geometry. Clements and Battista (1992) stated "if a concept is tied too closely to a single image, its critical attributes might not be recognized … because of over reliance on this image" (p. 444). Particularly, repetitive exposure to angle demonstrations drawn with similar characteristics, such as equal length arms and right hand orientation may deceive students to believe that these features are critical properties of angles (Scally, 1991). Students need to see shapes drawn in various orientations as the facilities of drama based instruction by providing them a chance to form a shape, be a part of a shape. Forming shapes allowed students to look at an object in many different orientations. For example since students had the opportunity to see several angles formed with their arms, legs or any other parts of body their bodies, they could easily be convinced that an angle does not need to have one horizontal ray. Furthermore seeing shapes in several perspectives helped them to recognize critical attributes of the shapes. All of these were likely to facilitate experimental group students' relatively better understanding of the concepts taught than their control group counterparts.

The significant difference in achievement in this study was partly attributable to capability of drama based instruction to enable the EG students to work together (Farris & Parke, 1993; Kelner, 1993; Wagner 1985). Working in groups made the students learn the responsibility, provided motivation to learn, and enabled them to acquire knowledge by seeing others' behaviors, receiving different ideas, and understanding others points of view. As students helped each other, they learned from each other. Moreover teaching each other provided them to learn better. In other words, the social interaction between the students assisted the construction of knowledge. Another benefit gained from the group work was the development of the friendship relation positively. Students had a chance to know their classmates. While students become more close to their friends, they could freely take risks without negative peer pressure. This was the result of the atmosphere of acceptance created by drama based instruction.

Drama based activities provided more interaction thereby communication among students. Consistent with the literature, since students worked in groups in most of the lessons, the communication skills were developed automatically (Barnes, 1998a), students became a better negotiators and communicators and were better able to express their own opinions and ideas (Ballou, 2000; Bolton, 1985; Kelner, 1993; Southwell, 1997; Yassa, 1999). Communication allows students opportunities to talk about their ideas, get feedback for their thinking and hear others' points of view. Talking about mathematics makes it more alive and more personal thus lightened students' interest (Wragg & Brown, 1995). By the communication provided by drama based instruction, a platform where the students and teacher were operating the same van Hiele geometric level of understanding about the geometric concepts was provided. As van Hiele (1986) stated communicating at the same language provided students understand geometry meaningfully and develop their geometric thinking level. As an advantage of communication, students became consciously aware of what they were studying on. Having time to reflect their ideas allowed them to make and test conclusions that related the mathematical ideas. For example they discussed on properties and classes of quadrilaterals thus build their own understandings of shapes.

Findings from the interviews also appear to suggest that students' awareness about themselves also had a positive effect on their performance. Students felt and realized their individual talents and their own characteristics which they were not aware before. This finding supports the findings of Yassa (1999), who showed that drama activities enable students to search for new possibilities within themselves. Students' knowledge and beliefs about themselves as mathematics learners both affects their performance in mathematics and their behaviors as they do mathematics (Reys, Suydam, Lindquist, & Smith, 1998). Some students claimed that they realized their intelligence and ability to succeed in mathematics, to create something, and to teach their friends. Some of them mentioned that they realized their potentials of being successful in mathematics. Learning about themselves provided them to gain confidence in themselves. Classroom teacher also mentioned that drama based instruction improve students' confidence in themselves as conforming the students interview results. This finding is concurrent with Farris and Parke (1993), Freeman (2000), Yaffe (1989), and Yassa (1999), who revealed that drama activities bring self-confidence to the participants. As the students are more active, and always deal with their social environment, they get used to be expressing themselves and fear of making mistakes lessen (Yaffe, 1989; Yassa, 1999). These can automatically bring the confidence to them. The previous studies showed that the achievement and self-confidence in mathematics are significantly correlated (Ames, 1992; Kloosterman, 1988; Kloosterman & Cougan, 1994). Askew and William (1995) stated "if students have confidence in their ability,… they will seek challenges and show persistence in the face of difficulties. However if they lack confidence in their ability, they will try to avoid challenges and show little persistence because they believe that they are likely to fail" (p. 28).

The students, experienced drama based instruction, were significantly better on retention of angles and polygons; and circle and cylinder achievement than the CG students exposed to traditional teaching. Adjusted R^2 for delayed posttest scores of angles and polygons and circle and cylinder achievement test revealed as .712 and .781, respectively. Considering these R^2 values, the treatment effect sizes were calculated as 2.472 and 3.566 for delayed posttest scores, respectively. These large effect sizes claim the practical significance of this result. The MANCOVA calculated the power for the comparing the delayed posttest scores as 1.00 that was higher than the preset value. At the beginning of the study, the power of the study calculated as between .90 and .95 for this analysis.

The result of the study related with the retention of achievement is also consistent with the result of Omniewski (1999), who found the positive effects of the drama based instruction on retention of mathematics achievement. Besides, the publications on theoretical aspects of drama also emphasized that drama based instruction supports the retention (Annarella, 1992; Kelner, 1993; Southwell, 1999). This finding also was validated with the students' and teacher's interview responses that claim drama based instruction promote long lasting learning. As students stated active participating, seeing the reasons behind what they were learning, and feeling the necessity of learning personally made their learning long lasting. On the other hand, traditional teaching is criticized for forcing students to rote memorization in geometry learning (Fuys, Geddes & Tischler, 1988; Mayberry, 1983), as memorization will be faced to forgetting or confusing information. Retention in mathematics achievement can be provided in two ways; meaningful learning, and connections to show children how mathematical ideas are related (Reys, Suydam, Lindquist, & Smith, 1998). Both these two requirements were satisfied by drama based instruction. As students indicated rather than rote learning out of context offered by traditional teaching, drama based instruction provided the meaningful learning with the help of real life examples which were easier, more logical, interesting, and familiar for them. If the context of the problem is familiar to the students, their understanding of the mathematical situation can be enhanced (Civil, 1998; Gialamsa, Karaliopoulou, Klaoudatos, Matrozos, & Papastavridis, 1999; Presmeg, 1998) and they can be more motivated to learn (Bussi & Boero, 1998, Koirala, 1999; Wyndhamn & Saljo, 1997). Daily life examples were helpful to make the students appreciate the importance of geometry by showing them application of the geometry in daily life and providing them a sense of when and how to use it. Activities embedded in real life context stimulated students thinking and their interest to geometry.

Another cause for long lasting learning can be attributed to active involvement of the students by improvising, measuring, forming, discussing, thinking, helping, explaining, etc. and the benefits of this participation like learning better, remembering longer, and enjoying more. Students emphasized in the interviews that they were more active by physically and cognitively in these lessons. As it is suggested by the constructivism learner should be the constructor of the personal knowledge rather than receivers and repeaters of given knowledge. Only by this way learning is more meaningful, applicable and memorable (Davis, Maher & Noddings, 1990). NCTM strongly suggests the active involvement to learning, in several important documents (NCTM, 1989; 1991; 2000). In Principles and Standards for School Mathematics (NCTM, 2000) it is stated that, understanding of mathematical ideas can be built if students actively engaged in tasks and experiences designed to deepen and connect their knowledge.

The use of long-term memory is greatly enhanced by the use of drama since the students is acting out and using different senses (Annarella, 1992). In drama based lessons the students have a purpose to learn the concept. Dramatic moments serve to create a purpose for the learning activity beyond “the teacher said to do it” and that makes the learning more permanent (Andersen, 2000). Another plausible reason for strengthening the retention is the personal involvement of the students. As a previous study showed, learning through experience encourages permanent learning (Bellizia, 1985).

The comparison of the angles and polygons; and circle and cylinder achievement showed that the experimental group showed less decrease from immediate to delayed posttest in circle and cylinder achievement test than angles and polygons achievement test. As stated by Okvuran (1993) and Freeman (2000) the length of treatment is an important factor in evaluating effects of drama. They stated that an orientation period is necessary for students to participate effectively in drama based activities. Particularly, while students were exposed 25-lesson hours drama based instruction before the circle and cylinder achievement test; they were received 14-lesson hours drama based instruction before the administration of the angles and polygons achievement test. The latter period might not be long enough to allow the children to become comfortable in drama based instruction settings.

Besides affirming the effectiveness of the drama based instruction in facilitating explicit understanding and improving achievement, this study implicated that this method also had a positive effect on students' Van Hiele geometric thinking level. Adjusted R^2 revealed as .262 for the posttest scores of van Hiele geometric thinking level test. Taking this value the treatment effect size was calculated as 0.355 which claims the practical significance of the result related with the van Hiele geometric thinking levels.

The EG students' correct response percentages to all questions of VHL increased from pretest to posttest. The CG students' correct responses, however, showed sharp decreases in the first and the third level questions. Among the first level questions, sharp decreases were noticed on the tasks related to identifying triangle, square, and parallelogram. Particularly a tendency was detected on the distracters involving the prototypical examples. This might be the most probably result of textbook oriented teaching. In the textbook used in the CG (Yıldırım, 2001), for example, square is not given in any oriented form. The textbook gave the example of a square with the sides of which are parallel to the edges of pages, and the example of parallelogram whose two pairs of sides are parallel to edges of the page. On the other hand, drama based instruction allowed the students to form the shapes by their bodies, so provided a chance to see the shapes in different perspectives. Related with the third level questions, the CG scores displayed sharp decreases on tasks of comprehending hierarchy between square and rectangle, comparing rectangle and parallelogram, and ordering properties of triangle. The correct response frequencies for the third level questions showed that few students realized that the "square is also rectangle" in the posttest. Furthermore, smaller number students realized the relationship between sides and angles of a triangle from pretest to posttest. This implied that students failed to logically order shapes and properties of shapes. This is another outcome of textbook oriented geometry instruction. In the textbook used in the CG (Yıldırım, 2001), each quadrilateral was explained as an isolated concept, the relation and hierarchy of quadrilaterals were not emphasized. Therefore students failed to understand the hierarchy between the quadrilaterals.

Although the EG students performed significantly better on the VHL than the CG students, the mean score difference from pretest to posttest did not indicate a large difference. Previous researches (van Hiele-Geldof, 1984; Johnson, 2002) indicated that it takes time for students to raise their van Hiele levels; perhaps the treatment period was not enough time for the change occurs. A longer period of time is needed for students to make significant gains in van Hiele levels.

Findings of this study added an empirical support for the positive effect of the drama based instruction on mathematics and geometry attitude compared to the traditional teaching. Adjusted R^2 value for posttest scores on mathematics and geometry attitude were .373 and .316, respectively. Considering these R^2 values, the treatment effect sizes were calculated as 0.461 and 0.355 which claim the practical significance of this result. The MANCOVA calculated the power for the comparing the posttest scores as 1.00 that was higher than the preset value.

Increase in attitude can be explained by the fun students had during the drama based lessons. This method provided students understand the topic through an enthusiastic engagement. In the interviews, some students mentioned how enjoyful time they had during activities. While they had fun during the lessons, their attitude increased. They implied that they willingly participated to the lessons. As literature suggested, the development of positive mathematical attitudes is linked to the direct involvement of students in activities (cited from Bergeson, Fitton, and Bylsma, 2000).

The result of the study related with the attitude is similar to the findings of Üstündağ (1997) and Kamen (1992), who found attitude toward content area significantly increased through the use of the drama based instruction. Drama based instruction had an effect on some or all dimensions of attitude. As the students indicated in the interviews some of them realized that the importance of geometry in their daily life, some students have gained confidence by engaging activities, because of several reasons (excitement, group work, etc.) students got motivation to the lessons. Each/all of these can a reason(s) for increasing attitudes.

Exciting and interesting classroom environment took students' attention and provided them to learn better as students claimed in the interviews. Consistent with Freeman (2000) and Kamen (1992), students enjoyed participating in drama based instructed lessons. As they stated they were looking forward to the drama based instructed lessons. In contrast to traditional teaching method, drama based instruction provided them an exciting, motivating and interesting environment. The enthusiasm about drama based instruction may caused by the opportunity of changing teacher's and students' roles in the classroom, therefore changing students' perspectives of what it means to do mathematics and their ability to do mathematics.

Another reason for the positive effect on attitude can be stemmed from the discovery students made during the lessons. Interaction in an inquiry based mathematics classroom motivates the particular constructions of individual students (Cobb, 2000; Wragg & Brown, 1995).

This finding is prominent when considering the suggestions of Reys, Suydam, Lindquist, and Smith (1998) that children can learn best when mathematical topics are presented in an enjoyable and interesting way that challenges their intellectual development.

It is important to note that, the analysis failed to detect a significant difference on mathematics attitude score between groups, after accounting the effect of drama based instruction on angles and polygons; and circle and cylinder achievement, Van Hiele geometric thinking level and geometry attitude. Furthermore, the effect of drama based instruction on students' geometry attitude was not significant, after accounting its effect on angles, and polygons, circle and cylinder achievement, Van Hiele geometric thinking level and mathematics attitude. This means that, the results related with attitudes toward mathematics and geometry should be interpreted with caution. It is claimed that attitudes are relatively stable and one should not expect noteworthy changes to occur over a short period of time (Nicolaidou & Philippou, 2004). The duration of the study might not be enough to change students' attitudes toward mathematics and geometry, uniquely. Moreover, attitude toward mathematics is a by-product of learning and is linked to both motivation and success in mathematics (Reys, Suydam, Lindquist, & Smith, 1998). A relation between mathematics attitude and mathematics achievement was also revealed by the previous researches (Aiken, 1976; Capraro, 2000; Ma, 1997; Ma & Kishor, 1997). With these ideas, these findings might be interpreted as the students' success in geometry could be the cause of the improvements in attitude score.

6.2 Conclusions

Internal and external validity threats of the study were sufficiently controlled by the settings of the study. Treatment and the administration of the instruments were carried out in regular classrooms during the regular lesson hours. As the study carried out in the same school, all the conditions were more or less the same. Since the conditions were similar in all of the classes, the threats related to the ecological validity were controlled.

The accessible population of the study was the seventh grade students in Balgat district, Ankara. The subjects were the seventh grade students of a school from this area. Since the sample of the study was chosen by the nonrandom sample of convenience, generalizability of the research was limited. Conclusion offered in this study can be applied to a broader population of similar sample.

The quantitative analyses and the interviews confirmed that the drama based instruction had a significant effect on students' angles and polygons achievement, circle and cylinder achievement, retention of these achievement, Van Hiele geometric thinking level, mathematics attitude, and geometry attitude compared to the traditional teaching.

Significantly better performance of the EG students was attributable to the potential of the drama based instruction to make learning easy and understanding better by; (a) supporting active involvement, (b) creating group work environment, (c) giving chance to improvise daily life examples, (d) giving opportunity to communicate (e) providing meaningful learning, (f) providing long lasting learning, and (g) providing self-awareness.

6.3 Implications

This study holds the following implications for educational practice:

- Geometry topics of angles, polygons, circle and cylinder can be taught effectively and efficiently in the specified period of time given in the curriculum by carefully developed drama based lesson plans.

•The significantly better performance of the treatment group in the given instruments suggests that drama based lessons should be developed in other topics of geometry and mathematics.

•Curriculum developers should take the effectiveness of drama based instruction into consideration during curriculum development process. They could involve drama based instruction as a teaching method in new curricula.

•Authors of mathematics education books should consider this method as an effective teaching method in mathematics education and give examples of drama based lesson plans in their books.

•By considering the comparison of the effectiveness of drama based instruction on the first (angles and polygons) and the second topics (circle and cylinder), the length of the study should permit for an initial period during which an environment for thrust and cooperation can be created and the students get used to the drama based activities.

•In order to use drama based instruction in the mathematics classroom teachers should be given a chance to improve their understanding of drama based instruction and develop their confidence to be able to implement drama based lesson. National Ministiry of Education should provide in-service training for teachers.

•Preservice teacher training programs should involve a course to inform prospective teacher about the benefits of drama based instruction and assist them to gain knowledge and skills about preparation of drama based lesson plans and implemention of drama based lessons.

•As the teacher saw the preparing the drama based lesson plans as a burden, teachers should be provided with the carefully planned drama based lesson plans.

•As the teacher and students feel the pressure of examinations, they believe the necessity of solve questions to gain procedural skills only. It can be said that it is not easy for our students who are motivated to the preparation of examination to appreciate the meaningful learning situation. The reward of meaningful learning should be emphasized in schools.

• Considering the difficulty of controlling the students in classroom, it would be better to use drama based instruction in class with smaller number of students or decrease the class size.

• School administrators should help teachers on implementing drama based lesson plans like providing music players, music CDs/cassettes, and classes with more spaces to facilitate drama based lessons. School administrators could prepare workshops about how to put into practice a drama based lesson.

6.4 Recommendations for Further Researchers

Based on the results of this study, the following recommendations are made for further researchers.

- More quantitative studies should be conducted on the effects of drama in different mathematics topics. More researches on the comparison of the effects of drama based instruction and other teaching method would be profitable.
- This study revealed that several aspects of drama based instruction have an effect on students' achievement, retention of achievement, attitude and van Hiele levels. In order to investigate which characteristics of drama based instruction is an aid to learn some particular mathematics topics would be illuminating. Qualitative studies to provide a deep understanding about how drama based instruction can helpful in mathematics learning will be fruitful for further researchers.
- Further research is recommended to consider students' previous achievement to minimize the affect of previous achievement on the outcomes.
- Learning style of the students can be taken into consideration. A study to determine effects of drama based instruction on the students with different learning preference would be fruitful.
- Replication of this study on different grades sample and other mathematics topics are recommended to provide more in-depth results. This would help to determine whether drama based instruction is an effective

teaching method for a wider range of age groups and regardless of the concepts being taught.

- Replication of this study with real classroom teachers instructing would helpful to determine whether drama based instruction is an effective teaching method regardless of the implementer.
- Complete randomization if provided in a replication of this study would allow researcher to generalize over a wider population.
- It is also recommended that the drama based instruction be videotaped in future researches so that some more information can be gathered from students' behaviors, gestures, and participation etc.

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APPENDIX A

ANGLES AND POLYGONS ACHIEVEMENT TEST

AÇILAR ve ÜÇGENLER BAŞARI TESTİ

Adı Soyadı:

Sevgili Öğrenci;
Bu test açılar ve çokgenler ünitesi ile ilgili 17 sorudan oluşmaktadır. Bazı sorular bir ya da birkaç alt soru içermektedir. Bazıları ise açıklama yapmanızı istemektedir. Sorulardaki alt sorulara verilecek cevaplara ve yapacağınız açıklamalara karşılık gelen puan değerleri bulunmaktadır. Bu testten alacağınız puanlar sözlü notu olarak değerlendirilecektir. Lütfen tüm soruları cevaplamaya çalışınız.
Sınav süresi 60 dakikadır.
Başarılar….

1. Üç doğru birbirine göre kaç değişik şekilde bulunabilir? Çiziniz ve açıklayınız.

2. Aşağıdaki seçeneklerde verilen kenar uzunlukları ile üçgen çizilip çizilemeyeceğini belirtiniz. Sebebini açıklayınız.

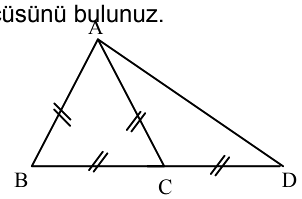
a) 2, 5, 7

b) 9, 2, 6

c) 8, 5, 5

d) 2, 6, 2

3. Aşağıdaki şekilde |AB| = |BC| = |AC| = |CD|dir. Bu durumda şekildeki D açısının ölçüsünü bulunuz.



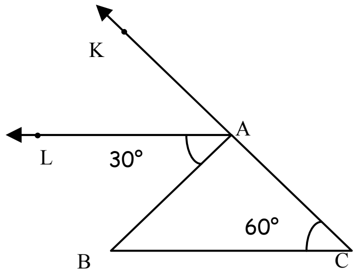
4. Bir ABC üçgeninde s (Â) = 35º, s (B) = 55º ise a, b ve c kenarlarının uzunluklarını büyükten küçüğe doğru sıralayın. Sıralamanın sebebini açıklayın.

5. Aşağıdaki şekilde [BC] // [AL, s(ACB) = 60° ve s (BÂL) = 30°dir. Buna göre

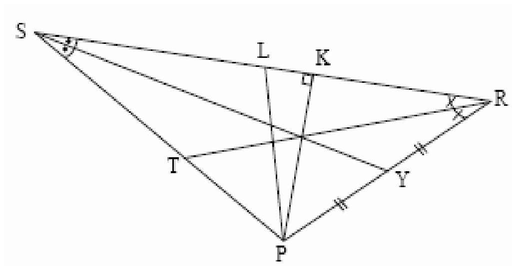
a. KAL açısı kaç derecedir?

b. ABC açısı kaç derecedir?

c. BÂC kaç derecedir?



6. Aşağıda SRP üçgeni verilmiştir. Bu üçgende s(RSY) = s (YSP), s(SRT) = s(TRP), s(SKP) = 90°, |SR| ⊥ |PK|, |SL| = |RL|, |RY| = |YP| bilgileri verilmektedir. Buna göre bu şekilde gördüğünüz SPR üçgenine ait



a. Aşağıdaki doğru parçalarından kenarortay olanları yuvarlak içine alınız. Altına sebebini yazınız.

[PL], [PK], [SY], [RT], [PY], [YR], [SL], [RL]

Sebep:

b. Aşağıdaki doğru parçalarından açıortay olanları yuvarlak içine alınız**.** Altına sebebini yazınız.

[PL], [PK], [ST], [RT], [PY], [YR], [SL], [TP], [SY]

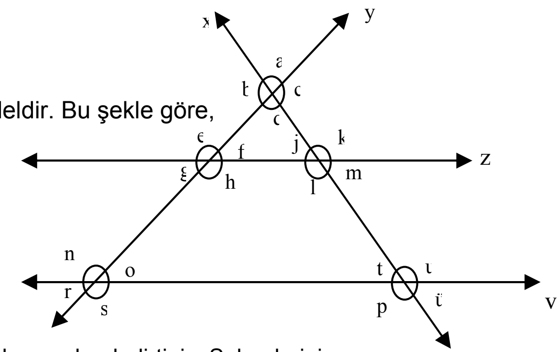
Sebep:

c. Aşağıdaki doğru parçalarından yükseklik olanları yuvarlak içine alınız**.** Altına sebebini yazınız.

[PL], [PK], [ST], [RT], [RK], [LK], [KS]

Sebep:

7. Yandaki şekilde x, y, z ve v doğruları ve bu doğrular arasında kalan açılar verilmiştir.
Bu doğrulardan v ile z doğruları birbirine paraleldir. Bu şekle göre,



a) Aşağıda verilen açılardan komşu olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

Açı	Komşu	Komşu değil	Sebebi
a ve c			
b ve c			
n ve o			
d ve j			
t ve u			
t ve ü			
t ve p			

b) Aşağıda verilen açılardan ters olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

Açı	Ters	Ters değil	Sebebi
e ve f			
e ve h			
e ve g			
r ve s			
ü ve u			
a ve d			
j ve m			
r ve n			

c) Aşağıda verilen açılardan yöndeş olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

Açı	Yöndeş	Yöndeş değil	Sebebi
e ve n			
a ve k			
n ve t			
b ve g			
k ve u			
j ve t			
s ve ü			
h ve s			

d) Aşağıda verilen açılardan iç ters olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

Açı	İçters	İçters değil	Sebebi
g ve n			
h ve l			
g ve o			
l ve u			
s ve u			
m ve t			

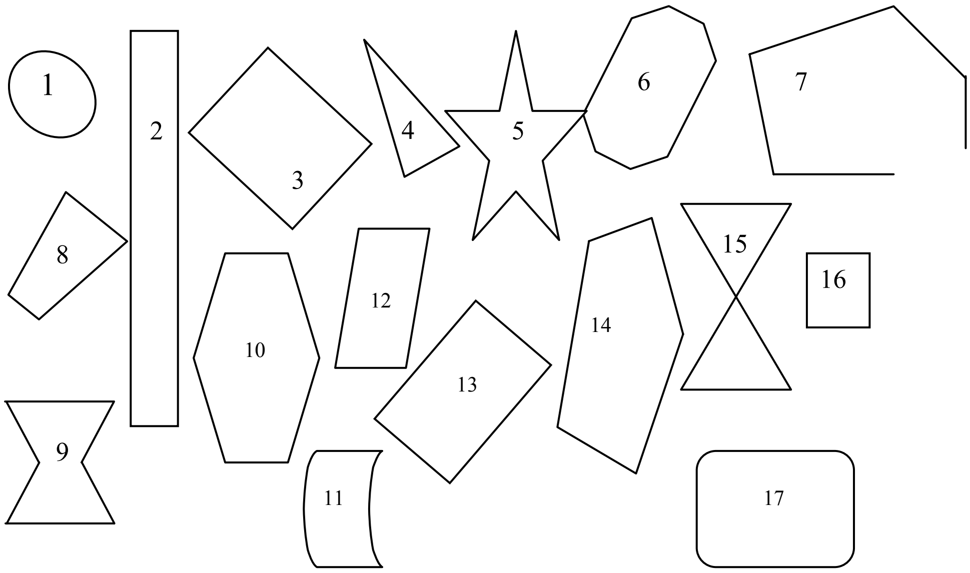
e) Aşağıda verilen açılardan dış ters olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

Açı	Dışters	Dışters değil	Sebebi
e ve s			
j ve p			
r ve ü			
k ve p			
k ve g			
j ve ü			

f) Aşağıda verilen açılardan ölçüleri eşit olanları ve olmayanları belirtiniz. Sebeplerini yazınız.

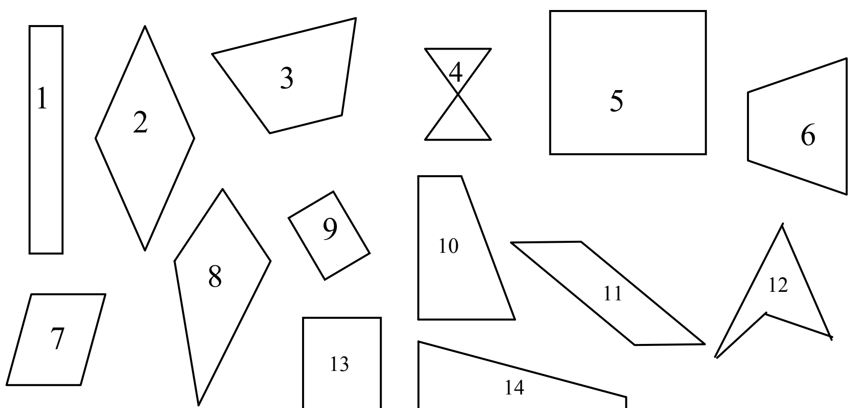
Açı	Eşit	Eşit değil	Sebebi
e ve s			
h ve l			
s ve h			
s ve ü			
g ve k			
p ve k			
p ve ü			
a ve d			
m ve t			
r ve u			

8. Aşağıda 17 tane geometrik şekil verilmiştir. Bu şekillere bakarak soruları cevaplayınız.
a) Şekillerden çokgen olanlar hangileridir? Sebebini açıklayınız. b) Şekillerden çokgen olmayanlar hangileridir? Sebebini açıklayınız.



9. Bir ABCD dörtgeninde s (Â) = 65°, s (B) = 40°, s (C) = 90° ise
a. D açısının ölçüsü nedir? b. A, B, C ve D köşelerindeki dış açılarının ölçüleri kaçar derecedir?

10. Aşağıda 14 tane geometrik şekil verilmiştir. Bu şekillere bakarak arka sayfadaki soruları cevaplayınız.



a) Yukarıdaki şekillerden kare olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Kare	Kare değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

b) Yukarıdaki şekillerden dikdörtgen olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Dikdörtgen	Dikdörtgen değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

c) Yukarıdaki şekillerden eşkenar dörtgen olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Eşkenar dörtgen	Eşkenar dörtgen değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

d) Yukarıdaki şekillerden paralelkenar olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Paralelkenar	Paralelkenar değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

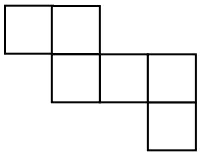
e) Yukarıdaki şekillerden yamuk olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Yamuk	Yamuk değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

b) Yukarıdaki şekillerden deltoid olanları ve olmayanları belirtiniz. Sebebini yazınız.

Şekil	Deltoid	Deltoid değil	Sebebi
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			

11. Aşağıda özdeş karelerden oluşan bir şekil verilmiştir. Bu şeklin alanı 294 cm^2dir. Şeklin çevresini bulunuz.



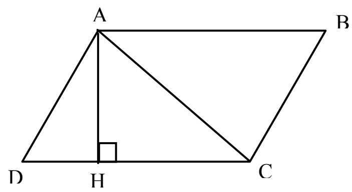
12. Bir deltoitin köşegenleri e = 12 cm ve f = 4 cmdir. Bu deltoitin alanını bulunuz.

13. Bir ikizkenar yamukta |AB| = |BC| = 10 cm ve |CD| = 15 cm olduğuna göre Bu yamuğun çevresini hesaplayınız.

14. Bir kenarının uzunluğu 40 m olan kare şeklindeki bir arazi ve bir kenarının uzunluğu yine 40 m olan eşkenar dörtgen büyüklüğünde başka bir arazi var. Bu arazilerin çevresi dikenli tel ile çevrilmek isteniyor. Hangi araziyi çevirmek için daha çok tel gerekir? Neden?

15. Kenar uzunlukları tamsayı olacak şekilde alanı 100 birim kare olacak dikdörtgenler oluşturulmak isteniyor. Çizilebilecek dikdörtgenleri kenar uzunluklarını belirterek yazınız.

16. Aşağıda ABCD paralelkenarında [AH] ⊥[DC] ve |AB| = 8 cm, |AH| = 4 cmdir. Buna göre aşağıdaki soruları cevaplayınız.
a. Paralelkenarın alanı kaç cm^2dir?
b. ABC üçgeni ile ABCD paralelkenarının alanı arasındaki ilişki nedir?



17. Alanı 40 cm^2 olan bir yamuğun yüksekliği 10 cm dir.
a. Tabanları toplamı kaç cm dir?
b. Üst tabanın uzunluğu alt taban uzunluğunun 3 katı olduğuna göre taban uzunluklarını bulunuz.

APPENDIX B

OBJECTIVES OF EACH TASK WITH ITS FREQUENCY AND PERCENTAGE FOR ANGLES AND POLYGONS ACHIEVEMENT TEST

Table B.1 Objectives of each task with its frequency and percentage for angles and polygons achievement test

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
1		Understand the positions of three lines being in a plane with respect to each other				
	i	Draw three parallel lines	55 (80.9)	48 (80.0)	11 (32.4)	12 (40.6)
	ii	Draw two parallel lines and one line intersecting them	54 (79.4)	49 (81.7)	11 (32.4)	11 (34.4)
	iii	Draw three lines intersecting mutually	35 (51.5)	27 (45.0)	6 (17.6)	16 (50)
	iv	Draw coinciding three lines	38 (55.9)	36 (60.0)	9 (26.5)	1 (3.1)
	v	Draw coinciding two lines parallel to another line	26 (38.2)	25 (41.7)	0 0	2 (6.3)
	vi	Draw coinciding two lines intersecting to another line	22 (32.4)	18 (30.0)	0 0	3 (9.4)
	vii	Draw lines intersecting at a point	44 (64.7)	48 (80.0)	15 (44.1)	8 (25.0)
2	Understand the triangular inequalities					
a	i	Determine whether a triangle can be constructed or not with the side lengths of 2, 5, and 7	55 (80.9)	43 (71.7)	11 (32.4)	12 (37.5)
	ii	Explain why a triangle can be constructed or not with the side lengths of 2, 5, and 7	51 (75.0)	35 (58.3)	2 (5.9)	5 (15.6)
b	i	Determine whether a triangle can be constructed or not with the side lengths of 9, 2, and 6	49 (72.1)	30 (50.0)	11 (32.4)	15 (46.9)
	ii	Explain why the above triangle can be constructed or not	47 (69.1)	20 (33.3)	3 (8.8)	5 (15.6)

Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
c	i	Determine whether a triangle can be constructed or not with the side lengths of 8, 8, and 5	51 (75.0)	46 (76.7)	17 (50)	8 (25.0)
	ii	Explain why a triangle can be constructed or not with the side lengths of 8, 8, and 5	50 (73.5)	34 (56.7)	3 (8.8)	3 (9.4)
d	i	Determine whether a triangle can be constructed or not with the side lengths of 2, 2, and 6	45 (66.2)	30 (50.0)	5 (11.7)	7 (21.9)
	ii	Explain why a triangle can be constructed or not with the side lengths of 2, 2, and 6	40 (58.8)	22 (36.7)	2 (5.9)	4 (12.5)
3		Find the angle measure of a triangle				
	i	Write each angle of an equilateral triangle is 60°	42 (61.8)	34 (56.7)	11 (32.4)	11 (34.4)
	ii	Find the measure of an exterior angle of a triangle	36 (52.9)	34 (56.7)	7 (20.6)	9 (28.1)
	iii	Find the measure of base angles of an isosceles triangle	23 (33.8)	30 (50.0)	5 (11.7)	8 (25.0)
4		Order the side lengths of the triangle				
	i	Find the measure of the one of the angle of a triangle given the measures of the other two angles	46 (67.6)	38 (63.3)	13 (38.2)	11 (34.4)
	ii	Order the side lengths of a triangle by considering the angle measures	46 (67.6)	27 (45.0)	2 (5.9)	9 (28.1)
5a	i	Find the corresponding angle in the given figure	26 (38.2)	32 (53.3)	11 (32.4)	5 (15.6)
b	i	Find the angle measure of a triangle in the given figure	26 (38.2)	31 (51.7)	10 (29.4)	4 (12.5)
c	i	Find the angle measure of a triangle in the given figure	29 (42.6)	30 (50.0)	10 (29.4)	4 (12.5)
6a		Identify the medians of the given triangle				
	i	Determine whether [PL] is a median of the triangle given or not	27 (39.7)	30 (50.0)	9 (26.5)	3 (9.4)
	ii	Determine whether [PK] is a median of the triangle given or not	45 (66.2)	37 (61.7)	6 (17.6)	6 (18.8)
	iii	Determine whether [SY] is a median of the triangle given or not	48 (70.6)	33 (55.0)	6 (17.6)	5 (15.6)
	iv	Determine whether [RT] is a median of the triangle given or not	46 (67.6)	33 (55.0)	7 (20.6)	1 (3.1)

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Table D.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
6a	v	Determine whether [PY] is a median of the triangle given or not	48 (70.6)	39 (65.0)	8 (23.5)	6 (18.8)
	vi	Determine whether [YR] is a median of the triangle given or not	48 (70.6)	39 (65.0)	12 (35.3)	5 (15.6)
	vii	Determine whether [SL] is a median of the triangle given or not	49 (72.1)	36 (60.0)	11 (32.4)	5 (15.6)
	viii	Determine whether [RL] is a median of the triangle given or not	51 (75.0)	40 (66.7)	8 (23.5).	5 (15.6)
	ix	Explain why the given segments are medians or not	17 (25.0)	6 (10.0)	2 (5.9)	1 (3.1)
b		Identify the angle bisectors of the given triangle				
	i	Determine whether [PL] is an angle bisector of the triangle given or not	52 (76.5)	40 (66.7)	8 (23.5)	6 (18.8)
	ii	Determine whether [PK] is an angle bisector of the triangle given or not	52 (76.5)	37 (61.7)	5 (14.7)	4 (12.5)
	Iii	Determine whether [ST] is an angle bisector of the triangle given or not	53 (77.9)	40 (66.7)	8 (23.5)	6 (18.8)
	Iv	Determine whether [RT] is an angle bisector of the triangle given or not	52 (76.5)	38 (63.3)	8 (23.5)	5 (15.6)
	v	Determine whether [PY] is an angle bisector of the triangle given or not	57 (83.8)	41 (68.3)	9 (26.5)	5 (15.6)
	vi	Determine whether [YR] is an angle bisector of the triangle given or not	57 (83.8)	42 (70.0)	9 (26.5)	7 (21.9)
	vii	Determine whether [SL] is an angle bisector of the triangle given or not	57 (83.8)	42 (70.0)	9 (26.5)	7 (21.9)
	viii	Determine whether [TP] is an angle bisector of the triangle given or not	57 (83.8)	42 (70.0)	10 (29.4)	7 (21.9)
	vi	Determine whether t and ü are adjacent angles or not	56 (82.4)	48 (80.0)	8 (23.5)	12 (37.5)
	ix	Determine whether [SY] is an angle bisector of the triangle given or not	55 (80.9)	38 (63.3)	6 (17.6)	4 (12.5)

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Table D.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
6b	x	Explain why the given segments are angle bisectors or not	25 (36.8)	6 (10.0)	4 (11.8)	1 (3.1)
6c		Identify the altitudes of the given triangle				
	i	Determine whether [PL] is an altitude of the triangle given or not	57 (83.8)	42 (70.0)	6 (17.6)	4 (12.5)
	ii	Determine whether [PK] is an altitude of the triangle given or not	59 (86.9)	44 (73.3)	5 (14.7)	6 (18.8)
	iii	Determine whether [ST] is an altitude of the triangle given or not	59 (86.9)	44 (73.3)	7 (20.6)	6 (18.8)
	iv	Determine whether [RT] is an altitude of the triangle given or not	60 (88.2)	42 (70.0)	7 (20.6)	5 (15.6)
	v	Determine whether [RK] is an altitude of the triangle given or not	60 (88.2)	44 (73.3)	7 (20.6)	6 (18.8)
	vi	Determine whether [LK] is an altitude of the triangle given or not	60 (88.2)	44 (73.3)	9 (26.5)	6 (18.8)
	vii	Determine whether [KS] is an altitude of the triangle given or not	60 (88.2)	44 (73.3)	6 (71.6)	7 (21.9)
	viii	Explain why the given segments are altitudes or not	20 (29.4)	5 (8.3)	3 (8.8)	1 (3.1)
7a		Identify adjacent angles constructed by two parallel lines and transversals				
	i	Determine whether a and c are adjacent angles or not	60 (88.2)	50 (83.3)	20 (58.8)	19 (59.4)
	ii	Determine whether b and c are adjacent angles or not	59 (86.9)	50 (83.3)	15 (44.1)	16 (50.0)
	iii	Determine whether n and o are adjacent angles or not	61 (89.7)	48 (80.0)	15 (44.1)	16 (50.0)
	iv	Determine whether d and j are adjacent angles or not	54 (79.4)	47 (78.3)	13 (38.2)	19 (59.4)
7	v	Determine whether t and u are adjacent angles or not	61 (89.7)	46 (76.7)	13 (38.2)	16 (50.0)
	vii	Determine whether t and p are adjacent angles or not	62 (91.2)	49 (81.7)	11 (32.4)	17 (53.1)
	viii	Explain why the given angles are adjacent angles	20 (29.4	13 (21.7)	1 (2.9)	1 (3.1)
	ix	Explain why the given angles are not adjacent angles	20 (29.4	12 (20.0)	3 (8.8)	1 (3.1)
b		Identify vertical angles constructed by two parallel lines and transversals				
	i	Determine whether e and f are vertical angles or not	60 (88.2)	52 (86.7)	20 (58.8)	17 (53.1)
	ii	Determine whether e and h are vertical angles or not	61 (89.7)	54 (90.0)	21 (61.8)	18 (56.3)
	iii	Determine whether e and g are vertical angles or not	60 (88.2)	54 (90.0)	23 (67.6)	20 (62.5)
	iv	Determine whether r and s are vertical angles or not	61 (89.7)	51 (85.0)	20 (58.8)	17 (53.1)
	v	Determine whether ü and u are vertical angles or not	59 (86.9)	55 (91.7)	21 (61.8)	19 (59.4)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	vi	Determine whether a and d are vertical angles or not	56 (82.4)	52 (86.7)	17 (50.0)	16 (50.0)
	vii	Determine whether j and m are vertical angles or not	62 (91.2)	55 (91.7)	20 (58.8)	18 (56.3)
	viii	Determine whether r and n are vertical angles or not	61 (89.7)	55 (91.7)	20 (58.8)	16 (50.0)
	ix	Explain why the given angles are vertical angles	16 (23.5)	7 (11.7)	2 (5.9)	0 0
	x	Explain why the given angles are not vertical angles	17 (25.0)	7 (11.7)	2 (5.9)	0 0
c		Identify corresponding angles constructed by two parallel lines and transversals				
	i	Determine whether e and n are corresponding angles or not	62 (91.2)=	56 (93.3)	24 (70.6)	22 (68.8)
	ii	Determine whether a and k are corresponding angles or not	42 (61.8)	32 (53.3)	10 (29.4)	13 (40.6)
	iii	Determine whether n and t are corresponding angles or not	41 (60.3)	28 (46.7)	16 (47.1)	9 (28.1)
	iv	Determine whether b and g are corresponding angles or not	35 (51.5)	33 (55.0)	10 (29.4)	11 (34.4)
7c	v	Determine whether k and u are corresponding angles or not	59 (86.8)	49 (81.7)	19 (55.9)	24 (75.0)
	vi	Determine whether j and t are corresponding angles or not	61 (89.7)	54 (90.0)	23 (67.6)	16 (50.0)
	vii	Determine whether s and ü are corresponding angles or not	34 (50.0)	31 (51.7)	18 (52.9)	9 (28.19
	viii	Determine whether h and s are corresponding angles or not	58 (85.3)	52 (86.7)	23 (67.6)	19 (59.49
	ix	Explain why the given angles are corresponding angles	22 (32.4)	15 (25.0)	2 (5.9)	1 (3.1)
	x	Explain why the given angles are not corresponding angles	16 (23.5)	14 (23.3)	2 (5.9)	0 0
d		Identify corresponding interior alternate angles constructed by two parallel lines and transversals				
	i	Determine whether g and n are interior alternate angles or not	55 (80.9)	47 (78.3)	21 (61.8)	15 (46.9)
	ii	Determine whether h and l are interior alternate angles or not	58 (85.3)	42 (70.0)	20 (58.8)	13 (40.6)
	iii	Determine whether g and o are interior alternate angles or not	53 (77.9)	40 (66.7)	22 (64.7)	15 (46.9)
	iv	Determine whether l and u are interior alternate angles or not	51 (75.0)	37 (61.7)	19 (55.9)	16 (50.0)
	v	Determine whether s and u are interior alternate angles or not	47 (69.1)	40 (66.7)	15 (44.1)	10 (31.3)
	vi	Determine whether m and t are interior alternate angles or not	50 (73.5)	42 (70.0)	20 (58.8)	15 (46.9)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
7d	vii	Explain why the given angles are interior alternate angles	13 (19.1)	3 (5.0)	1 (2.9)	1 (3.1)
	viii	Explain why the given angles are not interior alternate angles	11 (16.2)	3 (5.0)	0 0	1 (3.1)
e		Identify corresponding exterior alternate angles constructed by two parallel lines and transversals				
	i	Determine whether e and s are exterior alternate angles or not	62 (91.2)	49 (81.7)	19 (55.9)	18 (56.3)
	ii	Determine whether j and p are exterior alternate angles or not	56 (82.4)	45 (75.0)	18 (52.9)	17 (53.1)
	iii	Determine whether r and ü are exterior alternate angles or not	51 (75.0)	38 (63.3)	19 (55.9)	12 (37.5)
	iv	Determine whether k and p are exterior alternate angles or not	58 (85.3)	47 (78.3)	20 (58.8)	16 (50.0)
	v	Determine whether k and g are exterior alternate angles or not	36 (52.9)	29 (48.3)	16 (47.1)	8 (25.0)
	vi	Determine whether j and ü are exterior alternate or not	46 (67.6)	36 (60.0)	19 (55.9)	10 (31.3)
	vii	Explain why the given angles are exterior alternate angles	16 (23.5)	7 (11.7)	0 0	1 (3.1)
	viii	Explain why the given angles are not exterior alternate angles	16 (23.5)	7 (11.7)	0 0	1 (3.1)
f		Identify equal angles constructed by two parallel lines and transversals				
	i	Determine whether e and s are equal angles or not	55 (80.9)	46 (76.7)	20 (58.8)	20 (62.5)
	ii	Explain why e and s are equal angles or not	13 (19.1)	8 (13.3)	3 (8.8)	1 (3.1)
	iii	Determine whether h and l are equal angles or not	39 (57.4)	35 (58.3)	2 (5.9)	15 (46.9)
7f	iv	Explain why h and l are equal angles or not	7 (10.3)	2 (3.3)	0 0	0 0
	v	Determine whether s and h are equal angles or not	49 (72.1)	41 (68.3)	22 (64.9)	17 (53.1)
	vi	Explain why s and h are equal angles or not	14 (20.6)	9 (15.0)	3 (8.8)	0 0
	vii	Determine whether s and ü are equal angles or not	42 (61.8)	32 (53.3)	12 (35.3)	15 (46.9)
	viii	Explain why s and ü are equal angles or not	7 (10.3)	5 (8.3)	0 0	0 0
	ix	Determine whether g and k are equal angles or not	45 (66.2)	30 (50.0)	12 (35.3)	10 (31.3)
	x	Explain why g and k are equal angles or not	7 (10.3)	3 (5.0)	0 0	0 0
	xi	Determine whether p and k are equal angles or not	43 (63.2)	37 (61.7)	13 (38.2)	13 (40.6)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	x	Explain why g and k are equal angles or not	7 (10.3)	3 (5.0)	0 0	0 0
	xi	Determine whether p and k are equal angles or not	43 (63.2)	37 (61.7)	13 (38.2)	13 (40.6)
	xii	Explain why p and k are equal angles or not	8 (11.8)	5 (8.3)	1 (2.9)	0 0
	xiii	Determine whether p and ü are equal angles or not	43 (63.2)	37 (61.7)	10 (29.4)	16 (50.0)
	xiv	Explain why p and ü are equal angles or not	10 (14.7)	7 (11.7)	0 0	0 0
	xv	Determine whether a and d are equal angles or not	54 (79.4)	46 (76.7)	19 (55.9)	14 (43.8)
	xvi	Explain why a and d are equal angles or not	12 (17.6)	8 (13.3)	0 0	0 0
	xvii	Determine whether m and t are equal angles or not	52 (76.5)	40 (66.7)	9 (26.5)	14 (43.8)
	xvii	Explain why m and t are equal angles or not	10 (14.7)	6 (10.0)	0 0	0 0
	xix	Determine whether r and u are equal angles or not	43 (63.2)	30 (50.0)	16 (47.1)	15 (46.9)
	xx	Explain why r and u are equal angles or not	7 (10.3)	3 (5.0)	0 0	0 0
8		Identify whether given figures are polygons or not polygons				
a		Identify whether given figures are polygons				
	i	Determine whether the figure 2 is a polygon or not	55 (80.9)	48 (80.0)	10 (29.4)	10 (31.3)
	ii	Determine whether the figure 3 is a polygon or not	56 (82.4)	48 (80.0)	9 (26.5)	12 (37.5)
	iii	Determine whether the figure 4 is a polygon or not	44 (64.7)	43 (71.7)	8 (23.5)	11 (34.3)
	iv	Determine whether the figure 5 is a polygon or not	58 (85.3)	49 (81.7)	24 (70.6)	18 (56.3)
	v	Determine whether the figure 6 is a polygon or not	61 (89.7)	52 (86.7)	26 (76.5)	21 (65.6)
	vi	Determine whether the figure 8 is a polygon or not	54 (79.4)	52 (86.7)	17 (50.0)	12 (37.5)
8a	vii	Determine whether the figure 9 is a polygon or not	55 (80.9)	45 (75.0)	24 (70.6)	12 (37.5)
	viii	Determine whether the figure 10 is a polygon or not	60 (88.2)	54 (90.0)	27 (79.4)	22 (68.8)
	ix	Determine whether the figure 12 is a polygon or not	52 (76.5)	47 (78.3)	12 (35.3)	12 (37.5)
	x	Determine whether the figure 13 is a polygon or not	57 (83.8)	44 (73.3)	15 (44.1)	13 (40.6)
	xi	Determine whether the figure 14 is a polygon or not	57 (83.8)	50 (80.3)	27 (79.4)	17 (53.1)
	xii	Determine whether the figure 16 is a polygon or not	55 (80.9)	44 (73.39	10 (29.4)	12 (37.5)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	xiii	Explain why the given figures are polygon	27 (39.7)	11 (18.3)	30 (88.2)	0 0
b		Identify whether given figures are not polygons				
	i	Determine whether the figure 1 is a polygon or not	59 (86.8)	48 (80.0)	27 (79.4)	20 (62.5)
	ii	Explain why figure 1 is not polygon	30 (44.1)	10 (16.7)	1 (2.9)	0 0
	iii	Determine whether the figure 7 is a polygon or not	55 (80.9)	48 (80.0)	13 (38.2)	12 (37.5)
	iv	Explain why figure 7 is not polygon	25 (36.8)	11 (18.3)	1 (2.9)	0 0
	v	Determine whether the figure 11 is a polygon or not	54 (79.4)	49 (81.7)	24 (70.6)	18 (56.3)
	vi	Explain why figure 11 is not polygon	26 (38.2)	9 (15.0)	0	0 0
	vii	Determine whether the figure 15 is a polygon or not	21 (30.9)	19 (31.7)	7 (20.6)	9 (28.1)
	viii	Explain why figure 15 is not polygon	0	0	0	0 0
	ix	Determine whether the figure 17 is a polygon or not	44 (64.7	40 (66.7)	22 (64.7)	17 (53.1)
	x	Explain why figure 17 is not polygon	23 (33.8)	9 (15.0)	0	0 0
9		Find the interior and exterior angle of a quadrilateral				
a	i	Find a interior angle of a quadrilateral given the other angles	39 (57.4)	25 (41.7)	12 (35.3)	6 (18.8)
b	i	Find an exterior angle of a quadrilateral when the interior angle of the same vertex is given 115°	16 (23.5)	15 (25.0)	7 (20.6)	3 (9.4)
	ii	Find an exterior angle of a quadrilateral when the interior angle of the same vertex is given 140°	16 (23.5)	13 (21.7)	7 (20.6)	3 (9.4)
9b	iii	Find an exterior angle of a quadrilateral when the interior angle of the same vertex is given 90°	17 (25.0)	14 (23.3)	7 (20.6)	3 (9.4)
	iv	Find an exterior angle of a quadrilateral when the interior angle of the same vertex is given 15°	12 (17.6)	11 (18.3)	6 (17.6)	2 (6.3)
10						
a		Identify whether the given figures are square or not				
	i	Determine whether the figure 1 is a square or not	54 (79.4)	42 (70.0)	29 (85.3)	22 (68.8)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	ii	Explain why the figure 1 is a square or not	26 (38.2)	7 (11.7)	8 (23.5)	5 (15.6)
	iii	Determine whether the figure 2 is a square or not	38 (55.9)	35 (58.3)	16 (47.1)	21 (65.5)
	iv	Explain why the figure 2 is a square or not	18 (26.5)	2 (3.3)	3 (8.8)	0 0
	v	Determine whether the figure 3 is a square or not	62 (91.2)	52 (86.7)	28 (82.4)	29 (90.6)
	vi	Explain why the figure 3 is a square or not	32 (47.1)	9 (15.0)	7 (20.6)	6 (18.8)
	vii	Determine whether the figure 4 is a square or not	63 (92.6)	55 (91.7)	29 (85.3)	28 (87.5)
	viii	Explain why the figure 4 is a square or not	30 (44.1)	9 (15.0)	7 (20.6)	4 (12.5)
	ix	Determine whether the figure 5 is a square or not	49 (72.1)	40 (66.7)	22 (64.7)	22 (68.8)
	x	Explain why the figure 5 is a square or not	24 (35.3)	7 (11.7)	7 (20.6)	7 (21.9)
	xi	Determine whether the figure 6 is a square or not	62 (91.2)	57 (95.0)	28 (82.4)	25 (78.1)
	xii	Explain why the figure 6 is a square or not	29 (42.6)	9 (15.0)	7 (20.6)	6 (18.8)
	xiii	Determine whether the figure 7 is a square or not	43 (63.2)	26 (43.3)	13 (38.2)	9 (28.1)
	xiv	Explain why the figure 7 is a square or not	17 (25.0)	1 (1.7)	3 (8.8)	3 (9.4)
	xv	Determine whether the figure 8 is a square or not	59 (86.8)	54 (90.0)	29 (85.3)	28 (87.5)
	xvi	Explain why the figure 8 is a square or not	27 (39.7)	8 (13.3)	6 (17.6)	4 (12.5)
	xvii	Determine whether the figure 9 is a square or not	52 (76.5)	57 (95.0)	26 (76.5)	23 (71.9)
	xvii	Explain why the figure 9 is a square or not	28 (41.2)	1 (1.7)	5 (14.7)	2 (6.3)
	xix	Determine whether the figure 10 is a square or not	62 (91.2)	54 (90.0)	29 (85.3)	25 (78.1)
	xx	Explain why the figure 10 is a square or not	30 (44.1)	7 (11.7)	6 (17.6)	5 (15.6)
	xxi	Determine whether the figure 11 is a square or not	54 (79.4)	51 (85.0)	29 (85.3)	25 (78.1)
	xxii	Explain why the figure 11 is a square or not	26 (38.2)	7 (11.7)	6 (17.6)	5 (15.6)
	xxiii	Determine whether the figure 12 is a square or not	61 (89.7)	54 (90.0)	30 (88.2)	24 (75.0)
	xxiv	Explain why the figure 12 is a square or not	26 (38.2)	8 (13.3)	6 (17.6)	6 (18.8)
	xxv	Determine whether the figure 13 is a square or not	61 (89.7)	54 (90.0)	30 (88.2)	27 (84.4)
	xxvi	Explain why the figure 13 is a square or not	32 (47.1)	2 (3.3)	8 (23.5)	2 (6.3)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	xxvii	Determine whether the figure 14 is a square or not	62 (91.2)	55 (91.7)	29 (85.3)	25 (78.1)
	xxviii	Explain why the figure 14 is a square or not	27 (39.7)	9 (15.0)	7 (20.6)	5 (15.6)
b		Identify whether the given figures are rectangle or not				
	i	Determine whether the figure 1 is a rectangle or not	60 (88.2)	51 (85.0)	24 (70.6)	25 (78.1)
	ii	Explain why the figure 1 is a rectangle or not	27 (39.7)	0 0	3 (8.8)	0 0
	iii	Determine whether the figure 2 is a rectangle or not	52 (76.5)	46 (76.7)	28 (82.4)	27 (84.4)
	iv	Explain why the figure 2 is a rectangle or not	19 (27.9)	2 (3.3)	4 (11.8)	1 (3.1)
	v	Determine whether the figure 3 is a rectangle or not	53 (77.9)	52 (86.7)	27 (79.4)	21 (65.6)
	vi	Explain why the figure 3 is a rectangle or not	26 (38.2)	4 (6.7)	3 (8.8)	1 (3.1)
	vii	Determine whether the figure 4 is a rectangle or not	60 (88.2)	52 (86.7)	26 (76.5)	25 (78.1)
	viii	Explain why the figure 4 is a rectangle or not	23 (33.8)	4 (6.7)	1 (2.9)	1 (3.1)
	ix	Determine whether the figure 5 is a rectangle or not	59 (86.8)	47 (78.3)	24 (70.6)	24 (75.0)
	x	Explain why the figure 5 is a rectangle or not	27 (39.7)	0 0	3 (8.8)	0 0
	xi	Determine whether the figure 6 is a rectangle or not	59 (86.8)	52 (86.7)	26 (76.5)	25 (78.1)
	xii	Explain why the figure 6 is a rectangle or not	21 (30.9)	4 (6.7)	2 (5.9)	1 (3.1)
	xiii	Determine whether the figure 7 is a rectangle or not	45 (66.2)	43 (71.7)	24 (70.6)	24 (75.0)
	xiv	Explain why the figure 7 is a rectangle or not	17 (25.0)	3 (5.0)	4 (11.8)	1 (3.1)
	xv	Determine whether the figure 8 is a rectangle or not	56 (82.4)	52 (86.7)	25 (73.5)	26 (81.3)
	xvi	Explain why the figure 8 is a rectangle or not	23 (33.8)	4 (6.7)	1 (2.9)	1 (3.1)
	xvii	Determine whether the figure 9 is a rectangle or not	33 (48.5)	15 (25.0)	3 (8.8)	4 (12.5)
	xvii	Explain why the figure 9 is a rectangle or not	15 (22.1)	0 0	0	0 0
	xix	Determine whether the figure 10 is a rectangle or not	58 (85.3)	52 (86.7)	26 (76.5)	25 (78.1)
	xx	Explain why the figure 10 is a rectangle or not	25 (36.8)	4 (6.7)	2 (5.9)	1 (3.1)
	xxi	Determine whether the figure 11 is a rectangle or not	41 (60.3)	31 (51.7)	14 (41.2)	11 (34.4)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	xxii	Explain why the figure 11 is a rectangle or not	15 (22.1)	1 (1.7)	0 0	1 (3.1)
	xxiii	Determine whether the figure 12 is a rectangle or not	59 (86.8)	53 (88.3)	22 (64.7)	24 (75.0)
	xxiv	Explain why the figure 12 is a rectangle or not	21 (30.9)	4 (6.7)	0 0	1 (3.1)
	xxv	Determine whether the figure 13 is a rectangle or not	38 (55.9)	20 (33.3)	3 (8.8)	6 (18.8)
	xxvi	Explain why the figure 13 is a rectangle or not	21 (30.9)	1 (1.7)	0 0	1 (3.1)
	xxvii	Determine whether the figure 14 is a rectangle or not	57 (83.8)	50 (83.3)	23 (67.6)	23 (71.9)
	xxviii	Explain why the figure 14 is a rectangle or not	20 (29.4)	2 (3.3)	1 (2.9)	1 (3.1)
c		Identify whether the given figures are diamond or not				
	i	Determine whether the figure 1 is a diamond or not	50 (73.5)	36 (60.0)	16 (47.1)	13 (40.6)
	ii	Explain why the figure 1 is a diamond or not	12 (17.6)	3 (5.0)	1 (2.9)	0 0
	iii	Determine whether the figure 2 is a diamond or not	44 (64.7)	40 (66.7)	11 (32.4)	13 (40.6)
	iv	Explain why the figure 2 is a diamond or not	12 (17.6)	3 (5.0)	2 (5.9)	1 (3.1)
	v	Determine whether the figure 3 is a diamond or not	56 (82.4)	43 (71.7)	19 (55.9)	19 (59.4)
	vi	Explain why the figure 4 is a diamond or not	14 (20.6)	4 (6.7)	0	0 0
	vii	Determine whether the figure 4 is a diamond or not	54 (79.4)	48 (80.0)	21 (61.8)	21 (65.6)
	viii	Explain why the figure 1 is a diamond or not	11 (16.2)	4 (6.7)	1 (2.9)	0 0
	ix	Determine whether the figure 5 is a diamond or not	46 (67.6)	10 (66.7)	14 (41.2)	12 (37.5)
	x	Explain why the figure 5 is a diamond or not	10 (14.7)	3 (5.0)	0	0 0
	xi	Determine whether the figure 6 is a diamond or not	55 (80.9)	46 (76.7)	22 (64.7)	20 (62.5)
	xii	Explain why the figure 6 is a diamond or not	12 (17.6)	4 (6.7)	2 (5.9)	0 0
	xiii	Determine whether the figure 7 is a diamond or not	36 (52.9)	34 (56.7)	10 (29.4)	11 (34.4)
	xiv	Explain why the figure 7 is a diamond or not	7 (11.8)	3 (5.0)	1 (2.9)	1 (3.1)
	xv	Determine whether the figure 8 is a diamond or not	52 (76.5)	43 (71.7)	18 (52.9)	19 (59.4)
	xvi	Explain why the figure 8 is a diamond or not	11 (16.2)	3 (5.0)	1(2.9)	0 0
	xvii	Determine whether the figure 9 is a diamond or not	45 (66.2)	36 (60.0)	8 (23.5)	10 (31.3)

Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	xviii	Explain why the figure 9 is a diamond or not	12 (17.6)	3 (5.0)	1 (2.9)	0 0
	xix	Determine whether the figure 10 is a diamond or not	56 (82.4)	43 (71.7)	22 (64.7)	21 (65.6)
	xx	Explain why the figure 10 is a diamond or not	13 (19.1)	4 (6.7)	1 (2.9)	0 0
	xxi	Determine whether the figure 11 is a diamond or not	47 (69.1)	42 (70.0)	17 (50.0)	15 (46.9)
	xxii	Explain why the figure 11 is a diamond or not	12 (17.6)	4 (6.7)	1 (2.9)	0 0
	xxiii	Determine whether the figure 12 is a diamond or not	54 (79.4)	45 (75.0)	19 (55.9)	19 (59.4)
	xxiv	Explain why the figure 12 is a diamond or not	11 (16.2)	4 (6.7)	1 (2.9)	0 0
	xxv	Determine whether the figure 13 is a diamond or not	38 (55.9)	33 (55.0)	7 (20.6)	10 (31.3)
	xxvi	Explain why the figure 13 is a diamond or not	16 (23.5)	3 (5.0)	1 (2.9)	0 0
	xxvii	Determine whether the figure 14 is a diamond or not	54 (79.4)	43 (71.7)	21 (61.8)	19 (59.4)
	xxviii	Explain why the figure 14 is a diamond or not	11 (16.2)	4 (6.7)	1 (2.9)	0 0
d		Identify whether the given figures are parallelogram or not				
	i	Determine whether the figure 1 is a parallelogram or not	37 (54.4)	38 (63.3)	5 (14.7)	16 (50.0)
	ii	Explain why the figure 1 is a parallelogram or not	15 (22.1)	4 (6.7)	0 0	0 0
	iii	Determine whether the figure 2 is a parallelogram or not	32 (47.1)	26 (43.3)	5 (14.7)	12 (37.5)
	iv	Explain why the figure 2 is a parallelogram or not	12 (17.6)	4 (6.7)	0 0	0 0
	v	Determine whether the figure 3 is a parallelogram or not	47 (69.1)	45 (75.0)	15 (44.1)	13 (40.6)
	vi	Explain why the figure 3 is a parallelogram or not	11 (16.2)	5 (8.3)	0 0	0 0
	vii	Determine whether the figure 4 is a parallelogram or not	46 (67.6)	4 (6.7)	15 (44.1)	13 (40.6)
	viii	Explain why the figure 4 is a parallelogram or not	9 (13.2)	4 (6.7)	0 0	0 0
	ix	Determine whether the figure 5 is a parallelogram or not	32 (47.1)	33 (55.0)	5 (14.7)	8 (25.0)
	x	Explain why the figure 5 is a parallelogram or not	15 (22.1)	3 (5.0)	0 0	0 0
	xi	Determine whether the figure 6 is a parallelogram or not	47 (69.1)	44 (73.3)	19 (55.9)	16 (50.0)
	xii	Explain why the figure 6 is a parallelogram or not	8 (11.8)	4 (6.7)	0 0	0 0
	xiii	Determine whether the figure 7 is a parallelogram or not	49 (72.1)	41 (68.3)	15 (44.1)	13 (40.6)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	xiv	Explain why the figure 7 is a parallelogram or not	14 (20.6)	4 (6.7)	0 0	0 0
	xv	Determine whether the figure 8 is a parallelogram or not	47 (69.1)	44 (73.3)	14 (41.2)	15 (46.9)
	xvi	Explain why the figure 8 is a parallelogram or not	8 (11.8)	4 (6.7)	0 0	0
	xvii	Determine whether the figure 9 is a parallelogram or not	28 (41.2)	27 (45.0)	5 (14.7)	8 (25.0)
	xvii	Explain why the figure 9 is a parallelogram or not	10 (14.7)	3 (5.0)	0 0	0 0
	xix	Determine whether the figure 10 is a parallelogram or not	46 (67.6)	47 (78.3)	19 (55.9)	16 (50.0)
	xx	Explain why the figure 10 is a parallelogram or not	7 (10.3)	4 (6.7)	0 0	0
	xxi	Determine whether the figure 11 is a parallelogram or not	40 (58.8)	44 (73.3)	16 (47.1)	16 (50.0)
	xxii	Explain why the figure 11 is a parallelogram or not	12 (17.6)	4 (6.7)	0 0	0 0
	xxiii	Determine whether the figure 12 is a parallelogram or not	48 (70.6)	47 (78.3)	16 (47.1)	15 (49.6)
	xxiv	Explain why the figure 12 is a parallelogram or not	7 (10.3)	4 (6.7)	0	0 0
	xxv	Determine whether the figure 13 is a parallelogram or not	27 (39.7)	28 (46.7)	1 (2.99	7 (21.9)
	xxvi	Explain why the figure 13 is a parallelogram or not	10 (14.7)	3 (5.0)	0 0	0 0
	xxvii	Determine whether the figure 14 is a parallelogram or not	45 (66.2)	45 (75.0)	16 (47.1)	15 (46.9)
	xxviii	Explain why the figure 14 is a parallelogram or not	7 (10.3)	4 (6.7)	0	0 0
e		Identify whether the given figures are trapezoid or not				
	i	Determine whether the figure 1 is a trapezoid or not	57 (83.8)	46 (76.7)	21 (61.8)	18 (56.3)
	ii	Explain why the figure 1 is a parallelogram or not	6 (8.8)	1 (1.7)	0 0	0 0
	iii	Determine whether the figure 2 is a trapezoid or not	55 (80.9)	49 (81.7)	18 (52.9)	13 (40.6)
	iv	Explain why the figure 2 is a parallelogram or not	6 (8.8)	1 (1.7)	0	0 0
	v	Determine whether the figure 3 is a trapezoid or not	51 (75.0)	46 (76.7)	18 (52.9)	13 (40.6)
	vi	Explain why the figure 3 is a parallelogram or not	4 (5.9)	0 0	0	0 0
	vii	Determine whether the figure 4 is a trapezoid or not	55 (80.9)	42 (70.0)	19 (55.9)	15 (46.9)
	viii	Explain why the figure 4 is a parallelogram or not	6 (8.8)	1 (1.7)	0 0	0 0
	ix	Determine whether the figure 5 is a trapezoid or not	55 (80.9)	47 (78.3)	20 (58.8)	21 (65.6)

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	x	Explain why the figure 5 is a parallelogram or not	7 (10.3)	1 (1.7)	0 0	0 0
	xi	Determine whether the figure 6 is a trapezoid or not	53 (77.9)	43 (71.7)	18 (52.9)	13 (40.6)
	xii	Explain why the figure 6 is a parallelogram or not	5 (7.4)	0 0	0 0	0 0
	xiii	Determine whether the figure 7 is a trapezoid or not	57 (83.8)	48 (80.0)	19 (55.9)	19 (59.4)
	xiv	Explain why the figure 7 is a parallelogram or not	7 (10.3)	1 (1.7)	0 0	0 0
	xv	Determine whether the figure 8 is a trapezoid or not	54 (79.4)	46 (76.7)	19 (55.9)	17 (53.1)
	xvi	Explain why the figure 8 is a parallelogram or not	7 (10.3)	1 (1.7)	0 0	1 (3.1)
	xvii	Determine whether the figure 9 is a trapezoid or not	57 (83.8)	47 (78.3)	17 (50.0)	17 (53.1)
	xviii	Explain why the figure 9 is a parallelogram or not	7 (10.3)	1 (1.7)	0	1 (3.1)
	xix	Determine whether the figure 10 is a trapezoid or not	51 (75.0)	44 (73.3)	15 (44.1)	15 (46.9)
	xx	Explain why the figure 10 is a parallelogram or not	5 (7.4)	0 0	0 0	0 0
	xxi	Determine whether the figure 11 is a trapezoid or not	56 (82.4)	49 (81.7)	17 (50.0)	19 (59.4)
	xxii	Explain why the figure 11 is a parallelogram or not	8 (11.8)	1 (1.7)	0	0 0
	xxiii	Determine whether the figure 12 is a trapezoid or not	46 (67.6)	36 (60.0)	11 (32.4)	9 (28.1)
	xxiv	Explain why the figure 12 is a parallelogram or not	8 (11.8)	1 (1.7)	0 0	0 0
	xxv	Determine whether the figure 13 is a trapezoid or not	54 (79.4)	46 (76.7)	20 (58.8)	20 (62.5)
	xxvi	Explain why the figure 13 is a parallelogram or not	8 (11.8)	1 (1.7)	0	0 0
	xxvii	Determine whether the figure 14 is a trapezoid or not	51 (75.0)	42 (70.0)	12 (35.3)	15 (46.9)
	xxviii	Explain why the figure 14 is a parallelogram or not	6 (8.8)	0 0	0 0	0 0
f		Identify whether the given figures are rhombus or not				
	i	Determine whether the figure 1 is a rhombus or not	59(86.8)	44 (73.3)	15 (44.1)	14 (43.8)
	ii	Explain why the figure 1 is a rhombus or not	3 (4.4)	1 (1.79	0 0	0 0
	iii	Determine whether the figure 2 is a rhombus or not	54 (79.4)	11 (18.3)	8 (23.5)	9 (28.1)
	iv	Explain why the figure 2 is a rhombus or not	3 (4.4)	0 0	0 0	0 0

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
	v	Determine whether the figure 3 is a rhombus or not	59 (86.8)	43 (71.7)	17 (50.0)	13 (40.6)
	vi	Explain why the figure 3 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	vii	Determine whether the figure 4 is a rhombus or not	56 (82.4)	46 (76.7)	13 (38.2)	16 (50.0)
	viii	Explain why the figure 4 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	ix	Determine whether the figure 5 is a rhombus or not	59 (86.8)	46 (76.7)	16 (47.1)	19 (59.4)
	x	Explain why the figure 5 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xi	Determine whether the figure 6 is a rhombus or not	59 (86.8)	45 (75.0)	18 (52.9)	17 (53.1)
	xii	Explain why the figure 6 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xiii	Determine whether the figure 7 is a rhombus or not	59 (86.8)	5 (8.3)	2 (5.9)	6 (18.8)
	xiv	Explain why the figure 7 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xv	Determine whether the figure 8 is a rhombus or not	59 (86.8)	41 (68.3)	13 (38.2)	10 (31.3)
	xvi	Explain why the figure 8 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xvii	Determine whether the figure 9 is a rhombus or not	59 (86.8)	10 (16.7)	3 (8.8)	6 (18.8)
	xvii	Explain why the figure 9 is a rhombus or not	3 (4.4)	0 0	0 0	0 0
	xix	Determine whether the figure 10 is a rhombus or not	59 (86.8)	45 (75.0)	15 (44.1)	18 (56.3)
	xx	Explain why the figure 10 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xxi	Determine whether the figure 11 is a rhombus or not	59 (86.8)	41 (68.3)	15 (44.1)	14 (43.8)
	xxii	Explain why the figure 11 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xxiii	Determine whether the figure 12 is a rhombus or not	55 (80.9)	43 (71.7)	16 (47.1)	12 (37.5)
	xxiv	Explain why the figure 12 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xxv	Determine whether the figure 13 is a rhombus or not	59 (86.8)	6 (10.0)	3 (8.8)	4 (12.5)
	xxvi	Explain why the figure 13 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xxvii	Determine whether the figure 14 is a rhombus or not	59 (86.8)	44 (73.3)	17 (50.0	17 (53.1)
	xxviii	Explain why the figure 14 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0
	xxviii	Explain why the figure 14 is a rhombus or not	3 (4.4)	1 (1.7)	0 0	0 0

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Table B.1 (continued)

Q	task	Objectives	EG		CG	
			POSTAPA (n=68)	DELAPA (n=60)	POSTAPA (n=34)	DELAPA (n=32)
11	i	Find the area of the square	33 (48.5)	19 (31.7)	8 (23.5)	3 (9.4)
	ii	Find the length of a side of a square	16 (23.5)	17 (28.3)	2 (5.9)	1 (3.1)
	iii	Find the perimeter of the shape	13 (19.1)	14 (23.3)	2 (5.9)	1 (3.1)
12	i	Find the area of the rhombus given the length of its diagonals	45 (66.2)	20 (33.3)	0 0	0 0
13	i	Find the perimeter of an isosceles trapezoid, given the length of the sides	9 (13.2)	11 (18.3)	4 (11.8)	1 (3.1)
14	i	Compare the perimeter of the square and the diamond whose side lengths are equal	28 (41.2)	16 (26.7)	5 (14.7)	0 0
15	i	Find the possible length of sides of 1 and 100 for a rectangle with the area of 100 cm^2	10 (14.7)	6 (10.0)	1 (2.9)	0 0
	ii	Find the possible length of sides of 2 and 50 for a rectangle with the area of 100 cm^2	13 (19.1)	6 (10.0)	2 (5.9)	0 0
	iii	Find the possible length of sides of 4 and 25 for a rectangle with the area of 100 cm^2	13 (19.1)	7 (11.7)	2 (5.9)	0 0
	iv	Find the possible length of sides of 5 and 20 for a rectangle with the area of 100 cm^2	12 (17.6)	1 (11.7)	2 (5.9)	0 0
	v	Find the possible length of sides of 10 and 10 for a rectangle with the area of 100 cm^2	11 (16.2)	1 (1.7)	0 0	0 0
16a	i	Find the area of a parallelogram given the sides of it	26 (38.2)	15 (25.0)	4 (11.8)	0 0
b	ii	Find the relation between the area of a parallelogram and the triangle in the parallelogram	17 (25.0)	6 (10.0)	2 (5.9)	0 0
17a	i	Find the sum of the bases of a trapezoid given the altitude and the area of it	11 (16.2)	5 (8.3)	1 (2.9)	0 0
b	ii	Calculate base lengths of the trapezoid	5 (7.4)	3 (5.0)	0 0	0 0

APPENDIX C

CIRCLE AND CYLINDER ACHIEVEMENT TEST

ÇEMBER ve SİLİNDİR BAŞARI TESTİ

Sevgili Öğrenciler;
Bu test açılar ve çokgenler ünitesi ile ilgili 15 sorudan oluşmaktadır. Bazı sorular bir ya da birkaç alt soru içermekte olup, bazıları ise açıklama yapmanızı istemektedir. Sorulardaki alt sorulara verilecek cevaplara ve yapacağınız açıklamalara karşılık gelen puan değerleri bulunmaktadır. Bu testten alacağınız puanlar sözlü notu olarak değerlendirilecektir. Lütfen tüm soruları cevaplamaya çalışınız.
Sınav süresi 40 dakikadır.
Başarılar….

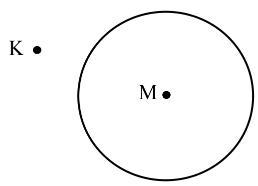
Adı Soyadı:

1. Çember ve daireye örnekler vererek aralarındaki farkı belirtiniz.

2. Bir çember üzerinde kaç tane yarıçap çizilebilir?Neden?

3. M merkezli, 4 cm. yarıçaplı bir çember ile |MC| = 3 cm, |MB| = 5 cm ve |MA| = 4 cm olan A, B ve C noktaları veriliyor.
a. Bu duruma uyan bir çember ve A, B ve C noktaları çiziniz.
b. A, B ve C noktalarının çembere göre konumlarını belirtiniz.

4. Aşağıda merkezi M ile gösterilen bir çember ve bu çemberin dışında bir K noktası verilmiştir. K noktasından geçen ve bu çembere teğet olan kaç tane doğru çizilebilir? Çiziniz.



5. Bir doğru bir çemberi en çok kaç noktada kesebilir? Çizim yaparak gösteriniz.

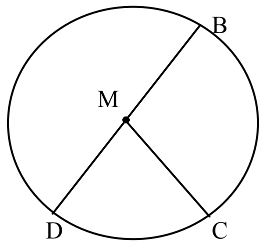
6. Yarıçap uzunluğu 10 cm olan bir çembere, uzunluğu 25 cm olan bir kiriş çizilebilir mi? Neden?

7. Bir çemberde, |AB| = 11 cm, |CD| = 9 cm ve |EF| = 7 cm olacak şekilde üç tane kirişi çiziliyor.
a. Bu kirişlerin belirledikleri yayların uzunluğu küçükten büyüğe doğru sıralayınız. Bu sıralamanın sebebini söyleyiniz.

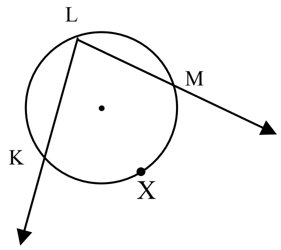
b. Bu kirişlerin merkeze en uzak ve en yakın olanını belirleyin. Sebebini açıklayın.
Merkeze en yakın kiriş:
Merkeze en uzak kiriş:
Sebebi:

8. Bir doğru bir çembere göre hangi durumlarda bulunabilir? Yazınız ve örnekleri çiziniz.

9. Aşağıda M merkezli bir çember verilmiştir. DMC açısı 80° ise küçük BC yayının açısal ölçüleri nedir?



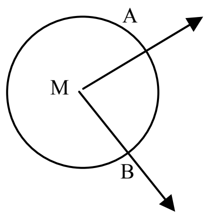
10. Aşağıdaki şekilde K, L, X ve M noktaları çemberin üstündedir. KL küçük yayının ölçüsü 110° ve LM küçük yayının ölçüsü 90° olduğuna göre, KLM açısının ve KXM yayının ölçüsünü bulunuz.



11. Aynı fiyata satılan 10 cm. çaplı pizzayı mı yoksa kenar uzunluğu 9 cm. olan kare pizzayı mı almak daha avantajlıdır? Neden? (∏ = 3)

12. Bir bisiklet tekerleği tam bir dönüş yaptığında 180 cm. yol alıyorsa, tekerleğin çapı nedir? (∏ = 3)

13. Aşağıdaki M merkezli bir çember verilmiştir. BMA açısının ölçüsü 90°, |MB| = 10 cm olduğuna göre oluşan küçük daire diliminin alanını bulunuz.



14. Bir dik çembersel silindir hangi geometrik şekillerden oluşur, açıklayınız, çizerek gösteriniz.

15. Taban dairesinin çapı 1 metre, yüksekliği 2 metre olan dik çembersel silindir şeklinde büyük karton bir kutu yapmak istiyoruz;
a. Bu kutunun alt ve üst kapaklarını yapmak için ne kadar kartona ihtiyaç vardır?
b. Kutunun yanal alanlarını yapmak için ne kadar kartona ihtiyaç vardır?
c. Kutunun tamamını yapmak ne kadar kartona ihtiyaç vardır?
d. Kutunun içine ne kadar su doldurulabilir?
(∏ = 3)

Table D.1 Objectives of each task with its frequency and percentage for circle and cylinder achievement test

Q	task	Objective	EG		CG	
			POSTCCA (n=68)	DELCCA (n=62)	POSTCCA (n=34)	DELCCA (n=32)
1	i	Give an example for a ring	60 (88,2)	56 (91,8)	12 (35,3)	12 (38,7)
	ii	Give an example for a circle	60 (88,2)	56 (91,8)	12 (35,3)	11 (35,5)
	iii	Explain differences between a ring and a circle	63 (92,6)	56 (91,8)	30 (88,2)	16 (51,6)
2	i	Write the number of radius could be drawn in a circle	53 (77,9)	49 (80,3)	11 (32,4)	12 (38,7)
	ii	Explain how many radius could be drawn in a circle	15 (22,1)	5 (8,2)	0 0	0 0
3 a	i	Draw the point on the circle, given the radius and the distance between the point and the center	48 (70,6)	31 (50,8)	3 (8,8)	0 0
	ii	Draw the point at the outside of the circle, given the radius and the distance between the point and the center	48 (70,6)	31 (50,8)	3 (8,8)	0 0
	iii	Draw the point at the inside of the circle, given the radius and the distance between the point and the center	47 (69,1)	31 (50,8)	2 (5,9)	0 0
b	i	Name the position of a point on the circle	14 (20,6)	16 (26,2)	1 (2,9)	0 0
	ii	Name the position of a point outside the circle	14 (20,6)	14 (23,0)	1 (2,9)	0 0
	iii	Name the position of a point inside the circle	13 (19,1)	16 (26,2)	2 (5,9)	0 0
4	i	Write the number of tangents drawn to the circle from a point outside of a circle	51 (75,0)	50 (82,0)	13 (38,2)	4 (12,9)
	ii	Draw tangents to the circle from a point outside of a circle	50 (73,5)	50 (82,0)	10 (29,4)	6 (19,4)

OBJECTIVES OF EACH TASK WITH ITS FREQUENCY AND PERCENTAGE FOR CIRCLE AND CYLINDER ACHIEVEMENT TEST

APPENDIX D

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Table D.1 (continued)

Q	task	Objective	EG		CG	
			POSTCCA (n=68)	DELCCA (n=62)	POSTCCA (n=34)	DELCCA (n=32)
5	i	Write the maximum number of point that a line intersect a circle	47 (69,1)	39 (63,9)	9 (26,5)	1 (3,2)
	ii	Draw a line that intersects a circle at a maximum number of point	44 (64,7)	38 (62,3)	5 (14,7)	2 (6,5)
6	i	Write whether it is possible or not to draw 25 cm chord to a circle with 10 cm radius	44 (64,7)	32 (52,5)	17 (50,0)	7 (22,6)
	ii	Explain why it is possible or not to draw 25 cm chord to a circle with 10 cm radius	40 (58,8)	25 (41,0)	8 (23,5)	0 0
7a	i	Compare the length of the arcs according to their chord lengths	39 (57,4)	20 (32,8)	11 (32,4)	0 0
	ii	Explain how the length of the chords and its distance to the center is related	19 (27,9)	11 (18,0)	2 (5,9)	0 0
	iii	Find the nearest chord to the center of the circle, given the chord lengths	43 (63,2)	25 (41,0)	6 (17,6)	0 0
b	i	Find the further chord to the center of the circle, given the chord lengths	41 (60,3)	25 (41,0)	5 (14,7)	0 0
	ii	Explain how the length of the chords and its distance to the center of the circle is related	28 (41,2)	14 (23,0)	1 (2,9)	0 0
8		Draw different positions of a line and a circle in a plane with respect to each other				
	i	Draw a line tangent to a circle	52 (76,5)	42 (68,9)	9 (26,5)	4 (12,9)
	ii	Draw a line constitutes a chord of a circle	52 (76,5)	42 (68,9)	10 (29,4)	4 (12,9)
	iii	Draw a line not intersecting circle	27 (39,7)	28 (45,9)	4 (11,8)	4 (12,9)
9	i	Find the measure of one of the angle on one side of diameter, given the measure of the other	46 (67,6)	45 (73,8)	23 (67,6)	3 (9,7)
	ii	Find the angle measure of arc, using the angle measure of its central angle	44 (64,7)	43 (70,5)	11 (32,4)	1 (3,2)

Table D.1 (continued)

Q	task	Objective	EG		CG	
			POSTCCA (n=68)	DELCCA (n=62)	POSTCCA (n=34)	DELCCA (n=32)
10	i	Find the measure of the one of arc in the circle, given the measure of the others	26 (38,2)	26 (42,6)	6 (17,6)	0 0
10	ii	Find the measure of the inscribed angle, using the measure of its arc	16 (23,5)	17 (27,9)	4 (11,8)	0 0
11	i	Find the area of a circle when the diameter is given	22 (32,4)	22 (36,1)	5 (14,7)	0 0
	ii	Find the area of a square when the length of a side is given	20 (29,4)	20 (32,8)	3 (8,8)	0 0
	iii	Compare the area of a circle and square	18 (26,5)	20 (32,8)	3 (8,8)	1 (3,2)
12	i	Find the radius of a circle given the perimeter of it	37 (54,4)	35 (57,4)	16 (47,1)	1 (3,2)
	ii	Find the diameter of a circle using the radius of it	23 (33,8)	28 (45,9)	5 (14,7)	0 0
13	i	Find the area of a circle given the distance between the center and a point on the circle is given	29 (42,6)	20 (32,8)	8 (23,5)	0 0
	ii	Find the area of a circle segment given the angle of the segment and the radius	24 (35,3)	12 (19,7)	3 (8,8)	0 0
14	i	Write the name of the shapes constitute a right circular cylinder	65 (95,6)	56 (91,8)	25 (73,5)	15 (48,3)
	ii	Draw an open form of a right circular cylinder	52 (76,7)	51 (83,6)	5 (14,7)	0 0
15	i	Find the base area of a cylinder given the length of the diameter and height of it	17 (25,0)	6 (9,8)	8 (23,5)	0 0
	ii	Find the lateral area of a cylinder given the length of the diameter and height of it	20 (29,4)	4 (6,6)	7 (20,6)	0 0
	iii	Find the area of a cylinder given the length of the diameter and height of it	18 (26,59	4 (6,6)	8 (23,5)	0 0
	iv	Find the volume of a cylinder given the length of the diameter and height of it	20 (29,4)	5 (8,2)	4 (11,8)	0 0

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APPENDIX E

VAN HIELE GEOMETRIC THINKING LEVEL TEST

VAN HIELE GEOMETRİ TESTİ

YÖNERGE

Bu test 25 sorudan oluşmaktadır. Sizden testteki her soruyu bilmeniz beklenmemektedir.

Kitapçığı açtığınızda;

1- **Bütün soruları dikkatlice okuyun.**

2- **Doğru olduğunu düşündüğünüz seçenek üzerinde düşünün. Her soru için tek bir doğru cevap vardır. Cevap kağıdına doğru olduğunu düşündüğünüz seçeneği işaretleyin.**

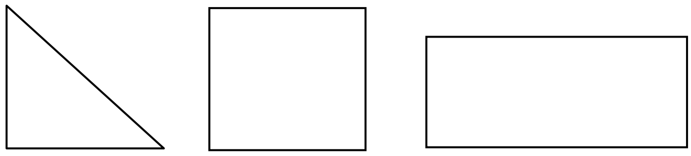
3- **Soru kağıdındaki boşlukları çizim yapmak için kullanabilirsiniz.**

4- **İşaretlemiş olduğunuz cevabı değiştirmek isterseniz, ilk işareti tamamen siliniz.**

5- **Bu test için size verilecek süre 35 dakikadır.**

VAN HIELE GEOMETRİ TESTİ

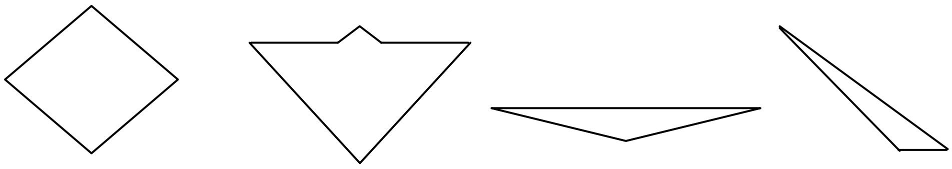
1- Aşağıdakilerden hangisi ya da hangileri karedir?



K L M

a) Yalnız K
b) Yalnız L
c) Yalnız M
d) L ve M
e) Hepsi karedir.

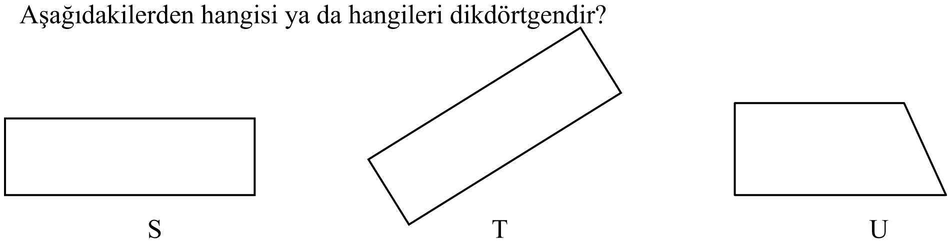
2- Aşağıdakilerden hangisi ya da hangileri üçgendir?



U V Y Z

a) Hiçbiri üçgen değildir.
b) Yalnız V
c) Yalnız Y
d) Y ve Z
e) V ve Y

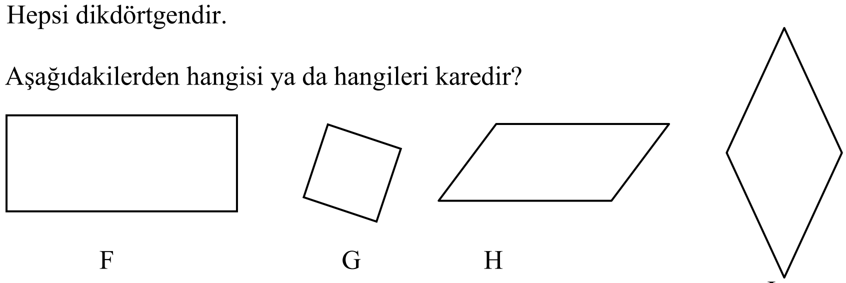
3- Aşağıdakilerden hangisi ya da hangileri dikdörtgendir?



S T U

a) Yalnız S
b) Yalnız T
c) S ve T
d) S ve U
e) Hepsi dikdörtgendir.

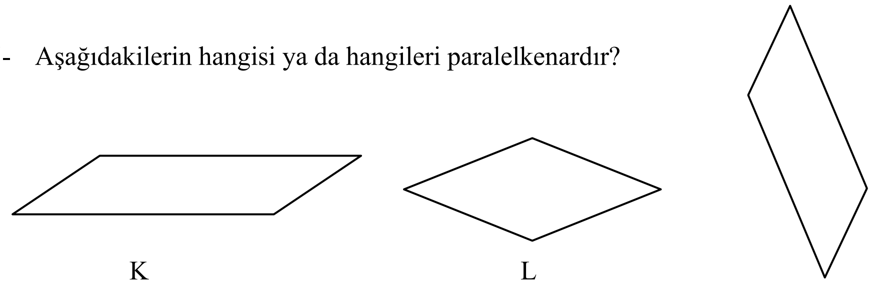
4- Aşağıdakilerden hangisi ya da hangileri karedir?



F G H I

a) Hiçbiri kare değildir.
b) Yalnız G
c) F ve G
d) G ve I
e) Hepsi karedir.

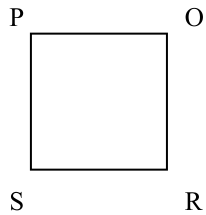
5- Aşağıdakilerin hangisi ya da hangileri paralelkenardır?



K L M

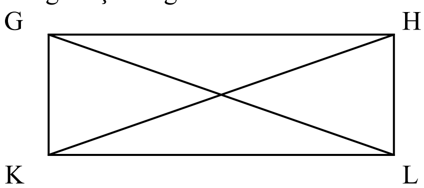
a) Yalnız K
b) Yalnız L
c) K ve M
d) Hiçbiri paralel kenar değildir.
e) Hepsi paralel kenardır.

6- PORS bir karedir.
Aşağıdakilerden hangi özellik her kare için doğrudur?



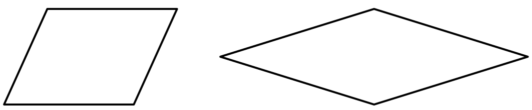
a) [PR] ve [RS] eşit uzunluktadır.
b) [OS] ve [PR] diktir.
c) [PS] ve [OR] diktir.
d) [PS] ve [OS] eşit uzunluktadır.
e) O açısı R açısından daha büyüktür.

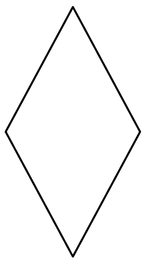
7- Bir GHJK dikdörtgeninde, [GL] ve [HK] <u>köşegendir</u>. Buna göre aşağıdakilerden hangisi <u>her</u> dikdörtgen için doğrudur?



a) 4 dik açısı vardır.
b) 4 kenarı vardır.
c) Köşegenlerinin uzunlukları eşittir.
d) Karşılıklı kenarların uzunlukları eşittir.
e) Seçeneklerin hepsi her dikdörtgen için doğrudur.

8- <u>Eşkenar dörtgen</u> tüm kenar uzunlukları eşit olan, 4 kenarlı bir şekildir. Aşağıda 3 tane eşkenar dörtgen verilmiştir.

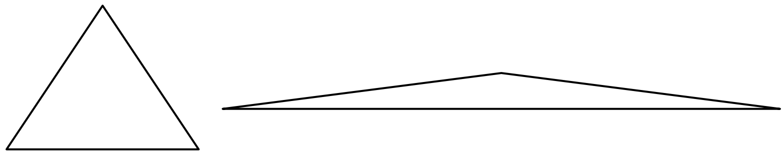


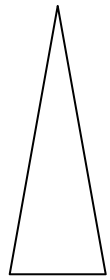


Aşağıdaki seçeneklerinden hangisi <u>her</u> eşkenar için doğru <u>değildir</u>?

a) İki köşegenin uzunlukları eşittir.
b) Her köşegen, aynı zamanda açıortaydır.
c) Köşegenleri birbirine diktir.
d) Karşılıklı açılarının ölçüsü eşittir.
e) Seçeneklerin hepsi her eşkenar dörtgen için doğrudur.

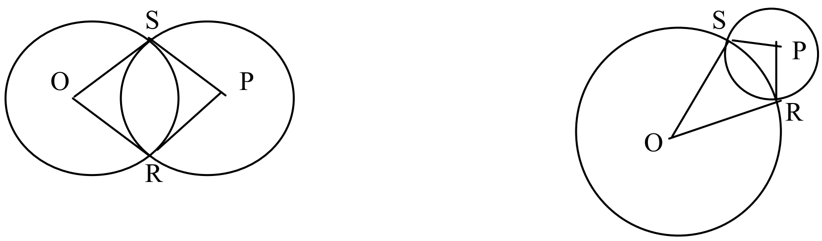
9- İkizkenar üçgen, iki kenarı eşit olan üçgendir. Aşağıda üç ikiz kenar üçgen verilmiştir.





Aşağıdaki seçeneklerinden hangisi <u>her</u> ikizkenar üçgen için doğrudur?
a) Üç kenarı eşit uzunlukta olmalıdır.
b) Bir kenarının uzunluğu, diğerinin iki katı olmalıdır.
c) Ölçüsü eşit olan en az iki açısı olmalıdır.
d) Üç açısının da ölçüsü eşit olmalıdır.
e) Seçeneklerinden hiçbiri her ikizkenar üçgen için doğru değildir.

10. Merkezleri birbirinin içinde yer almayan ve merkezleri P ve O ile adlandırılmış olan iki çember 4 kenarları PROS şeklini oluşturmak üzere R ve S noktalarında kesişirler. Aşağıda iki örnek verilmiştir.



Aşağıdaki seçeneklerinden hangisi her zaman doğru <u>değildir?</u>
a) PROS şeklinin iki kenarı eşit uzunlukta olacaktır.
b) PROS şeklinin en az iki açısının ölçüsü eşit olacaktır.
c) [PO] ve [RS] dik olacaktır.
d) P ve O açılarının ölçüleri eşit olacaktır.
e) Yukarıdaki seçeneklerin hepsi doğrudur.

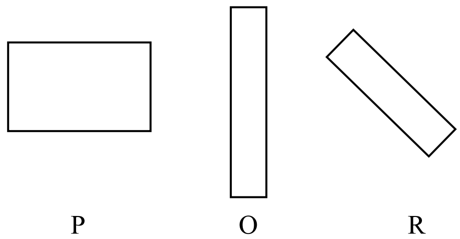
11. Önerme S: ABC üçgeninin üç kenarı eşit uzunluktadır.
Önerme T: ABC üçgeninde, B ve C açılarının ölçüleri eşittir.
Buna göre aşağıdakilerden hangisi doğrudur?

a) S ve T önermeleri ikisi de aynı anda doğru olamaz.
b) Eğer S doğruysa, T de doğrudur.
c) Eğer T doğruysa, S de doğrudur.
d) Eğer S yanlışsa, T de yanlıştır.
e) Yukarıdaki seçeneklerin hiçbiri doğru değildir.

12. Önerme 1: F şekli bir dikdörtgendir.
Önerme 2: F şekli bir üçgendir.

Bu iki önermeye göre aşağıdakilerden hangisi doğrudur?
a) Eğer 1 doğruysa, 2 de doğrudur.
b) Eğer 1 yanlışsa, 2 doğrudur.
c) 1 ve 2 aynı anda doğru olamaz.
d) 1 ve 2 aynı anda yanlış olamaz.
e) Yukarı seçeneklerin hiçbiri doğru değildir.

13. Aşağıdaki şekillerden hangisi ya da hangileri dikdörtgen olarak adlandırılabilir?

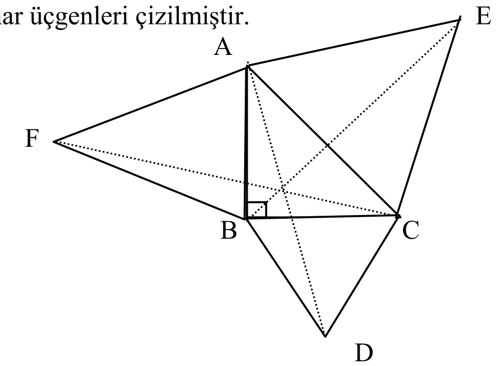


a) Hepsi
b) Yalnız O
c) Yalnız R
d) P ve O
e) O ve R

14. Tüm dikdörtgenlerde olup, bazı paralelkenarlarda olmayan özellik nedir?
a) Karşılıklı kenarları eşittir.
b) Köşegenler eşittir.
c) Karşılıklı kenarlar paraleldir.
d) Karşılıklı açıları eşittir.
e) Yukarıdaki seçeneklerin hiçbiri doğru değildir.

15- Aşağıdakilerden hangisi doğrudur?
a) Dikdörtgenlerin tüm özellikleri, tüm kareler için geçerlidir.
b) Karelerin tüm özellikleri, tüm dikdörtgenler için de geçerlidir.
c) Dikdörtgenin tüm özellikleri, tüm paralel kenarlar için geçerlidir.
d) Karelerin tüm özellikleri, tüm paralel kenarlar için geçerlidir.
e) Yukarıdaki seçeneklerin hiçbiri doğru değildir.

16- Aşağıda bir ABC dik üçgeni verilmiştir. ABC üçgeninin kenarları üzerinde; ACE, ABF ve BCD eşkenar üçgenleri çizilmiştir.



Bu bilgilerden [AD], [BE] ve [CF] ortak bir noktadan geçtikleri kanıtlanabilir. Bu kanıt size neyi ifade eder?
a) Yalnızca bu üçgen için; [AD], [BE] ve [CF] nin ortak bir noktası olduğundan emin olabiliriz
b) Sadece bazı dik üçgenlerde; [AD], [BE] ve [CF] nin ortak bir noktası vardır.
c) Herhangi bir dik üçgende, [AD], [BE] ve [CF]nin ortak bir noktası vardır.
d) Herhangi bir üçgende, [AD], [BE] ve [CF]nin ortak bir noktası vardır.
e) Herhangi bir eşkenar üçgende, [AD], [BE] ve [CF]nin ortak bir noktası vardır.

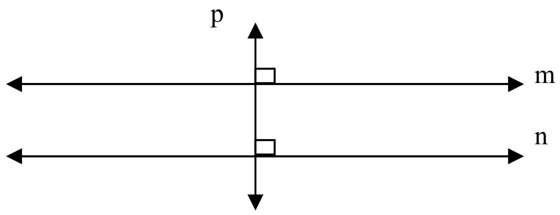
17- Aşağıda bir şeklin üç özelliği verilmiştir.
Özellik D: Köşegenleri eşit uzunluktadır.Özellik S: Bir karedir.Özellik R: Bir dikdörtgendir.
Bu özellikler dikkate alındığında aşağıdakilerden hangisi doğrudur?
a) D gerektirir S, o da gerektirir R.
b) D gerektirir R, o da gerektirir S.
c) R gerektirir D, o da gerektirir S.
d) R gerektirir S, o da gerektirir D.
e) S gerektirir R, o da gerektirir D.

18. Aşağıda iki önerme verilmiştir.
I- Eğer bir şekil dikdörtgense, köşegenleri birbirini ortalayarak keser.
II- Eğer bir şeklin köşegenleri birbirini ortalayarak kesiyorsa şekil dikdörtgendir.
Buna göre aşağıdakilerden hangisi doğrudur?

a) I'in doğru olduğunu kanıtlamak için, II nin doğru olduğunu kanıtlamak yeterlidir.
b) II'nin doğru olduğunu kanıtlamak için, I in doğru olduğunu kanıtlamak yeterlidir.
c) II'nin doğru olduğunu kanıtlamak için, köşegenleri birbirini ortalayan bir dikdörtgen bulmak yeterlidir.
d) II nin yanlış olduğunu kanıtlamak için, köşegenleri birbirini ortalayan dikdörtgen olmayan bir şekil bulmak yeterlidir.
e) Yukarıdaki seçeneklerin hiçbiri doğru değildir.

19- Aşağıdaki üç ifadeyi inceleyin.
{1} Aynı doğruya dik olan iki doğru paraleldir.
{2} İki paralel doğrudan birine dik olan doğru, diğerine de diktir.
{3} Eğer iki doğru eş uzaklıktaysa paraleldir.

Aşağıdaki şekilde, m ve p, n ve p doğrularının birbirine dik olduğu verilmiştir. Buna göre yukarıdaki cümlelerden hangisi ya da hangileri m doğrusunun n doğrusuna paralel olmasının nedeni olabilir?



a) Yalnız {1}
b) Yalnız {2}
c) Yalnız {3}
d) {1} ya da {2}
e) {2} ya da {3}

20- Aşağıdaki ifadelerden hangisi doğrudur?
Geometride,
a) Her terim tanımlanabilir ve her doğru önermenin doğru olduğu kanıtlanabilir.
b) Her terim tanımlanabilir ama bazı önermelerin doğru olduğunu varsaymak gerekir.
c) Bazı terimler tanımsız kalmalıdır, ama bütün doğru önermelerin doğruluğu kanıtlanabilir.
d) Bazı terimler tanımsız kalmalıdır ve doğru olduğu varsayılmış bazı önermelere gerek vardır.
e) Yukarıdaki seçeneklerinden hiçbiri doğru değildir.

21- Bir açıyı üçlemek demek onu üç eşit parçaya bölmek demektir. 1847 yılında, P.L. Wantzel bir açının yalnızca pergel ve işaretlenmemiş cetvel kullanarak <u>üçlenemeyeceğini</u> kanıtlamıştır. Bu kanıttan nasıl bir sonuca varabilirsiniz?

a) Açılar yalnızca pergel ve işaretlenmemiş cetvel kullanarak <u>iki eş</u> parçaya ayrılamazlar.
b) Açılar yalnızca pergel ve <u>işaretlenmiş</u> cetvel kullanarak üçlenemezler.
c) Açılar herhangi bir çizim aracı kullanarak üçlenemezler.
d) Gelecekte, birinin yalnız pergel ve işaretlenmiş cetvel kullanarak açıları üçlemesi mümkün olabilir.
e) Hiç kimse, açıları yalnızca pergel ve işaretlenmemiş cetvel kullanarak üçleyecek genel bir yöntem bulamayacaktır.

22- Ali adlı bir matematikçinin kendi tanımladığı geometriye göre, aşağıdaki önerme doğrudur.
Bir üçgenin iç açılarının ölçüsü toplamı 180 dereceden azdır.
Buna göre aşağıdakilerden hangisi doğrudur?
a) Ali üçgenin açılarını ölçerken hata yapmıştır.
b) Ali mantıksal bir hata yapmıştır.
c) Ali doğru sözcüğünün anlamını bilmiyordur.
d) Ali bilinen geometridekilerden farklı varsayımlarla başlamıştır.
e) Yukarıdaki seçeneklerden hiçbiri doğru değildir.

23- F geometrisinde, her şey alışık olduklarımızdan farklıdır. Burada sadece dört nokta ve 6 doğru vardır. Her doğru iki nokta içerir. Eğer P, O, R ve S nokta ise, {P,O}, {P,R}, {P,S}, {O,R}, {O, S} ve {R, S} doğrulardır.

. P   O .

. R   . S

Kesişme ve paralel terimlerinin F- geometrisindeki kullanımı şöyledir: {P, O} ve {P,R} doğruları P' de kesişirler çünkü P {P, O} ve {P,R} ın ortak noktasıdır. {P, O} ve {R, S} doğruları paraleldir çünkü ortak hiçbir noktaları yoktur.
Buna göre, aşağıdakilerden hangisi doğrudur?

a) {P, R} ve {O, S} kesişirler.
b) {P, R} ve {O, S} paraleldir.
c) {O, R} ve {R,S} paraleldir.
d) {P, S} ve {O, R} kesişirler.
e) Yukarıdaki seçeneklerin hiçbiri doğru değildir.

24- İki ayrı geometri kitabı 'dikdörtgen' sözcüğünü iki farklı şekillerde tanımlamıştır. Buna göre aşağıdakilerden hangisi doğrudur?
a) Kitaplardan birinde hata vardır.
b) Tanımlardan biri yanlıştır. Dikdörtgen için iki farklı tanım olamaz.
c) Bir kitapta tanımlanan dikdörtgenin özellikleri diğer kitaptakinden farklı olmalıdır.
d) Bir kitapta tanımlanan dikdörtgenin özellikleri diğer kitaptakiyle aynı olmalıdır.
e) Kitaplarda tanımlanan dikdörtgenlerin farklı özellikleri olabilir.

25- Varsayalım aşağıdaki önerme I ve II yi kanıtladınız.
I. Eğer p ise q dir.
II. Eğer s ise q değildir.
Buna göre önerme I ve II den aşağıdakilerden hangisi çıkartılabilir?
a) Eğer s ise, p değildir.
b) Eğer p değil ise q değildir.
c) Eğer p veya q ise s dir.
d) Eğer p ise s dir.
e) Eğer s değil ise p dir.

APPENDIX F

OBJECTIVES OF EACH TASK WITH ITS FREQUENCY AND PERCENTAGE FOR VAN HIELE GEOMETRIC THINKING LEVEL TEST

Table F.1 Objectives of each task with its frequency and percentage for van Hiele geometric thinking level test

Q	objective	EG		CG	
		PREVHL	POST VHL	PREVHL	POSTVHL
1	Identify square	66 (97,1)	65 (95,6)	32 (94,1)	31 (91,2)
2	Identify triangle	54 (79,4)	66 (97,1)	31 (91,2)	26 (76,5))
3	Identify rectangle	61 (89,7)	62 (91,2)	30 (88,2)	29 (85,3)
4	Identify square	35 (51,5)	37 (54,4)	21 (61,8)	15 (44,1)
5	Identify parallelogram	28 (41,2)	41 (60,3)	19 (55,9)	11 (32,4)
6	Comprehend properties of square	8 (11,8)	11 (16,2)	7 (20,6)	5 (14,7)
7	Comprehend properties of rectangle	33 (48,5)	46 (67,6)	8 (23,5)	16 (47,1)
8	Comprehend properties of diamond	11 (16,2)	17 (25,0)	8 (23,5)	8 (23,5)
9	Comprehend properties of isosceles triangles	28 (41,2)	40 (58,8)	23 (67,6)	20 (58,8)
10	Comprehend properties of radius and tangent of circle; and comprehend properties of rhombus	13 (19,1)	23 (33,8)	8 (23,5)	7 (20,6)
11	Show simple deduction related with properties of triangle	6 (8,8)	24 (35,3)	11 (32,4)	4 (11,8)
12	Show simple deduction related with rectangle and triangle	24 (35,3)	28 (41,2)	10 (29,4)	9 (26,5)
13	Comprehend hierarchy between square and rectangle.	44 (64,7)	46 (67,6)	25 (73,5)	13 (38,2)
14	Compare rectangle and parallelogram	5 (7,4)	15 (22,1)	11 (32,4)	5 (14,7)
15	Comprehend hierarchy between square, rectangle and parallelogram.	2 (2,9)	10 (14,7)	3 (8,8)	4 (11,8)

APPENDIX G

MATHEMATICS ATTITUDE SCALE

MATEMATİK DERSİNE YÖNELİK TUTUM ÖLÇEĞİ

Bu ölçek sizin matematik dersi ile ilgili düşüncelerinizi öğrenmek için hazırlanmıştır. Cümlelerden hiçbirinin kesin cevabı yoktur. Her cümleyle ilgili görüş, kişiden kişiye değişebilir. Bunun için vereceğiniz cevaplar kendi görüşünüzü yansıtmalıdır.Her cümleyle ilgili görüş belirtirken önce cümleyi dikkatle okuyunuz, sonra cümlede belirtilen düşüncenin, sizin düşünce ve duygunuza ne derecede uygun olduğuna karar veriniz.Cümlede belirtilen düşünceye
Hiç katılmıyorsanız, Hiç Uygun Değildir
Katılmıyorsanız, Uygun Değildir,
Kararsız iseniz, Karasızım
Kısmen katılıyorsanız, Uygundur
Tamamen katılıyorsanız, Tamamen Uygundur seçeneğini
İşaretleyiniz.

Ad Soyad:__________________________________ Cinsiyet:___________ Sınıf:______

	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç uygun Değildir
1. Matematik sevdiğim bir derstir.					
2. Matematik dersine girerken büyük bir sıkıntı duyarım.					
3. Matematik dersi olmasa öğrencilik hayatı daha zevkli olurdu.					
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 geçmek bilmez.					
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 H

GEOMETRY ATTITUDE SCALE

GEOMETRİYE YÖNELİK TUTUM ÖLÇEĞİ

Bu ölçek sizin geometri ile ilgili düşüncelerinizi öğrenmek için hazırlanmıştır. Cümlelerden hiçbirinin kesin cevabı yoktur. Her cümleyle ilgili görüş, kişiden kişiye değişebilir. Bunun için vereceğiniz cevaplar kendi görüşünüzü yansıtmalıdır.Her cümleyle ilgili görüş belirtirken önce cümleyi dikkatle okuyunuz, sonra cümlede belirtilen düşüncenin, sizin düşünce ve duygunuza ne derecede uygun olduğuna karar veriniz.Cümlede belirtilen düşünceye

Hiç katılmıyorsanız, Hiç Uygun Değildir
Katılmıyorsanız, Uygun Değildir,
Kararsız iseniz, Karasızım
Kısmen katılıyorsanız, Uygundur
Tamamen katılıyorsanız, Tamamen Uygundur seçeneğini
İşaretleyiniz.

Ad Soyad:___________________________ Cinsiyet:___________ Sınıf:______

	Tamamem Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç uygun Değildir
1. Okulda daha çok geometri dersi olmasını istemem.					
2. Matematikte diğer konulara göre geometriyi daha çok severek çalışırım.					
3. Matematikte en çok korktuğum konular geometri konularıdır.					
4. Geometri dersinde bir tedirginlik duyarım.					
5. Geometri dersinde gerginlik hissetmem.					
6. Geometri konuları ilgimi çekmez.					
7. Geometriyi seviyorum.					
8. Geometri dersinde kendimi huzursuz hissediyorum.					
9. Geometri sorularını çözmekten zevk almam.					
10. Geometri çalışırken vaktin nasıl geçtiğini anlamıyorum.					
11. Matematiğin en zevkli kısmı geometridir.					
12. Geometri dersi sınavından çekinmem.					

APPENDIX I

LESSON PLANS

ÜNİTE 5: *AÇILAR ve ÇOKGENLER*

DERS PLANI 1

ÜNİTE 5 *AÇILAR VE ÇOKGENLER*

HEDEF 1: Eş açıları kavrayabilme

Davranışlar:

D1. Bir noktada kesişen iki doğrunun oluşturduğu açılardan, komşu bütünler ve ters açıları gösterip yazma

D2. Ters iki açının kenarları arasındaki ilişkiyi söyleyip yazma

D3. Verilen bir açıya ters olan açıyı çizme

D4. Ters açıların ölçüleri arasındaki ilişkiyi söyleyip yazma

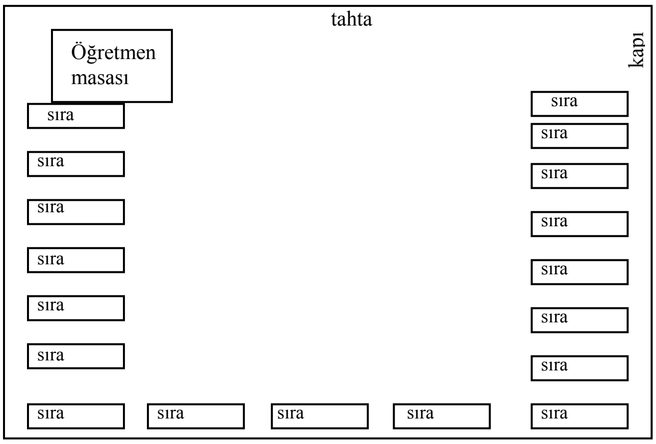
D5. Kesişen iki doğrunun oluşturduğu açılardan birini ölçüsü verildiğinde, diğerlerinin ölçülerini bulup yazma

Süre: 1 ders saati

Materyal: Kasetçalar, müzik kaseti, büyük açıölçer

Kullanılan drama teknikleri: Donuk imge, toplantı düzenleme, TV programı, öğretmenin role girmesi

Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

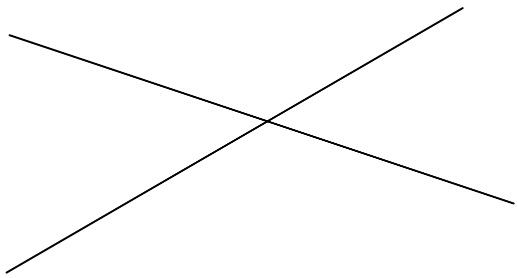
1. "Sınıfta müzik eşliğinde dolaşıyoruz. Tüm mekanı kullanmaya, sınıfta gitmediğiniz köşe, basmadığınız yer bırakmamaya çalışın. Adımlarınızı sıklaştırın. Daha hızlı hareket ediyorsunuz. Şimdi adımlar biraz yavaşladı. Yavaş yavaş yürüyoruz. Normal yürüyüşe geri dönün. Şimdi sınıfta zikzaklar çizerek yürüyoruz. Birbirinize çarpmamaya dikkate ederek, değişik yönlere doğru zikzaklar çizerek yürüyün."

2. “Şimdi herkes vücudunu kullanarak bir açı oluştursun. Açı ne demekti?” Öğrencilerin kollarını, ayaklarını, başını vs. kullanarak açı oluşturmaları sağlanır. Burada açı kavramı üzerinde konuşulur. “Oluşturduğunuz açıları biraz büyütün. Şimdi bu açıları biraz küçültün. “

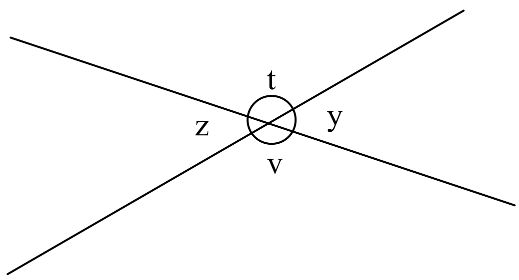
GELİŞTİRME ETKİNLİKLERİ

1. Sınıfın 4er kişilik gruplara ayrılması sağlanır. Öğretmen “Her grup kendi içinde günlük hayatımızda karşılaştığımız açılar düşünsün ve bunların bir listesini yapsın. Sonra her grup bu listeden istediği bir açının şeklini oluştursun ve bir süre bu şekilde donsun. Buna “donuk imge” diyoruz. Daha sonra her grubun oluşturduğu donuk imgeye sırayla bakacağız. Diğer gruplar size yarattığınız donuk imgeyle ilgili sorular sorabilirler. Eğer günlük hayattan canlandırdığınız o açının durumu kullanıma göre büyüyor ya da küçülüyor ise bir süre donup bekledikten sonra o açının hareketini bize gösterin” der ve öğrencilerin hazırlanmaları için süre verir. Öğrenciler hazırlanlarını bitirince, her grubun sunuşu izlenir.

2. Öğretmen “kimler bugüne kadar bir makas kullandı?” “Hiç kullanmayan var mı?” diye sorar. Ardından 4 kişinin bir makas oluşturmasını ister. Öğrencilerin aşağıdaki gibi bir makas oluşturmaları sağlanır. Öğretmen “Şimdi bu makasın hareketini bize gösterin” der. Makası oluşturan öğrencilerden aynı doğruyu oluşturan öğrencilerin doğru gibi hareket etmeleri beklenmektedir. Bu sırada diğer öğrencilere makası oluşturan öğrencilerin “bir makas gibi” hareket edip etmedikleri sorulur. Harekette yanlışlık varsa diğer öğrencilerin de katılımı ile makas hareketi bulunur. Burada gerekirse sınıfa getirilmiş olan makas gösterilebilir.



3. Öğretmen “Makasta açı var mı?” “Neresinde var?” “Makas üzerinde kaç tane açı var?” şeklinde sorular sorarak öğrencilerden makastaki açıları göstermeleri ister. Öğrenciler gösterdikten sonra oluşan makas şekli (aşağıdaki gibi) tahtaya çizilir ve üzerinde açılar işaretlenir.



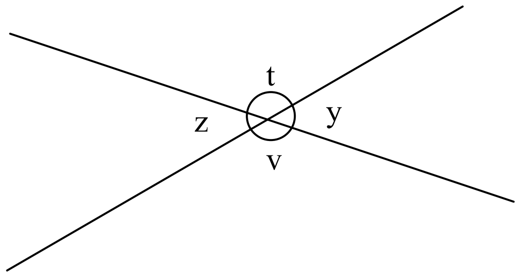
4. Öğretmen "Açıların pozisyonları hakkında ne söylersiniz?" der. Alınan cevaplarla bazı açıların yan yana, bazıların birbirinin tam tersinde durduğu düşüncesine yönlendirilir. Öğretmen "Yan yana olan açılara komşu açı, birbirine ters olan açılara ise ters açı diyoruz" diyerek tahtaya çizilen makasta komşu ve ters açıları gösterir. Makasta bulunan komşu açıların komşu bütünler olduğu söylenir. Öğrencilerden bu açılara bakarak ters açının ve komşu açının tanımını yapmaları istenir. Daha sonra öğretmen tahtaya

"Köşeleri ortak, kenarları zıt ışınlar olan açılara, ters açılar, bir kenarı ve köşesi ortak olan açılara komşu açılar denir. Birbirini 180° ye tamamlayan komşu açılar komşu bütünlerdir.

t ve v ile z ve y ters açılardır

t ve y, y ve v, v ve z, z ve t komşu bütünler açılardır" yazar.

5. Öğretmen "Makas açılıp kapanınca açılar ne oluyor?" Bu açıların büyüklükleri hakkında ne söylersiniz? " der. Açıkların büyüklüklerinin bulunabilmesi için hazırlanmış büyük açıölçerler öğrencilere verilir ve açıları ölçmeleri beklenir. Burada makasın açılması ve kapanması halinde makas üzerinde bulunan tüm açılardaki değişimler üzerinde konuşulur ve özellikle ters ve komşu açılardaki değişimler vurgulanır. Öğrencilerin ters açıların ölçülerinin birbirine eşit olduğunu görmeleri beklenir.



Öğretmen tahtaya

" *Ters açıların ölçüleri birbirine eşittir. Komşu bütünler açıların ölçüleri bütünlerdir yani birbirini 180° ye tamamlar;*

$s(t) = s(v)$

$s(z) = s(y)$

$s(t) + s(y) = 180°$

$s(v) + s(y) = 180°$

$s(v) + s(z) = 180°$

$s(t) + s(z) = 180°$" yazar.

6. Öğretmen "Şimdi sizler televizyon programı yapımcısısınız. Her bir grubun ters açı, komşu açı ve komşu bütünler açı ile ilgili olarak televizyonda yayınlanacak bir program hazırlamasını istiyorum. Bende TV programını değerlendirecek ve sahip olduğum TV kanalına satın alacak kişiyim. Bunun için 6 dakika süreniz var" der ve öğrencilere hazırlanmaları için süre verilir.

SONUÇ ETKİNLİKLERİ

1. Öğrencilerin hazırladıkları TV programlarını sunmaları istenir.

2. Öğrencilerin gruplar içinde çok hızlı bir biçimde komşu ve ters açıları donuk imge olarak canlandırmaları sağlanır. Daha sonra komşu bütünler ve ters açıların özelliklerini söylemeleri istenir.

DERS PLANI 2

Davranışlar:

D6. Bir düzlemde, üç doğrunun birbirine göre durumlarını söyleyip yazma

D7. Paralel iki doğrunun bir kesenle yaptığı açılardan, yöndeş, iç ters, dış ters açıları gösterip işaretleme

D8. Yöndeş, iç ters ve dış ters açıların özelliklerini söyleme

D9. Paralel iki doğrunun üçüncü bir doğru ile oluşturduğu açılardan, belirtilen bir açıya göre yöndeş, iç ters ya da dış ters olan açıları gösterme

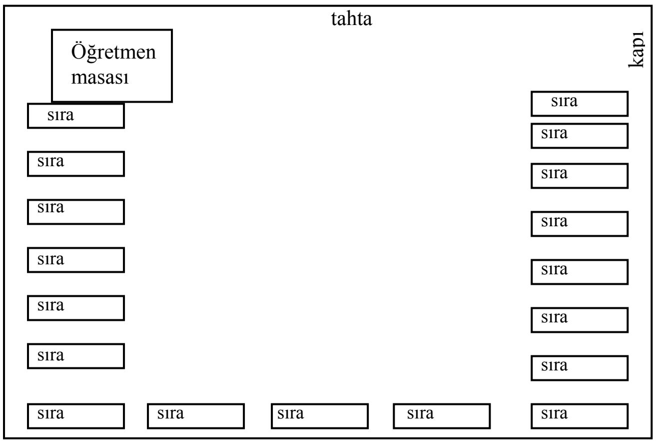
D10. Ters, iç ters, dış ters ve yöndeş açıların özelliklerinden faydalanarak çeşitli açı hesaplamaları yapma

Süre: 1 ders saati

Materyal: Kasetçalar, müzik kaseti, büyük gönyeler, ip

Kullanılan drama teknikleri: Donuk imge, toplantı düzenleme, TV programı, öğretmenin role girmesi

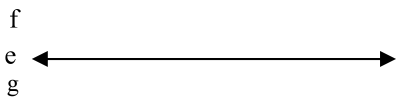
Sınıf yerleşim planı:



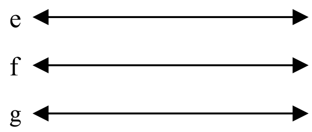
GİRİŞ ETKİNLİKLERİ:

1. Öğretmen "Sınıfta müzik eşliğinde dolaşıyoruz. Tüm mekanı kullanmaya, sınıfta gitmediğiniz köşe, basmadığınız yer bırakmamaya çalışın. Şimdi yavaş yavaş yürüyoruz. Adımlarımız sıklaştı ve hızlandık. Ben müziği durdurduğumda verdiğim yönergeyi uygulamanızı bekliyorum." der. Müzik ilk durdurulduğunda öğrencilerin hep birlikte bir tane doğru oluşturmaları, daha sonraki durduruluşlarında sırayla iki ve üç tane doğru oluşturmaları ister.

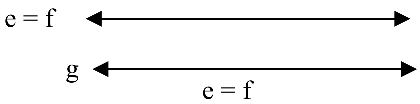
2. Müzik tekrar durdurulduğunda, öğretmen "bu kez yeniden 3 tane doğru oluşturmanızı istiyorum. Fakat bu kez doğruların durumları demin oluşturduğunuz üç doğrunun durumundan farklı olsun "der. Öğrencilerin oluşturduğu üç doğrunun demin bulundukları pozisyondan daha farklı bir şekilde olması beklenir. Müzik yeniden durdurulduğunda son yönerge tekrarlanarak bu kez üç doğrunun daha önce oluşturdukları 2 farklı durum dışındaki bir durumunu bulmaları söylenir. Sınıfta her bir şekil oluşturulduktan sonra öğretmen bu şekilleri tahtaya çizer. Bu oyun öğrenciler bu şekilde üç doğrunun birbirine göre yer alabilecekleri aşağıdaki 7 durum bulunana kadar devam ettirilir.



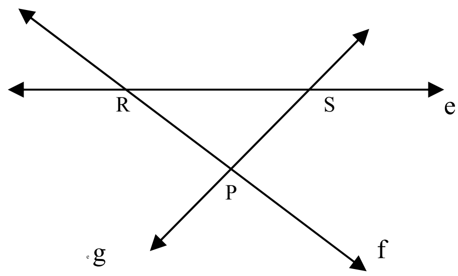
e = f = g



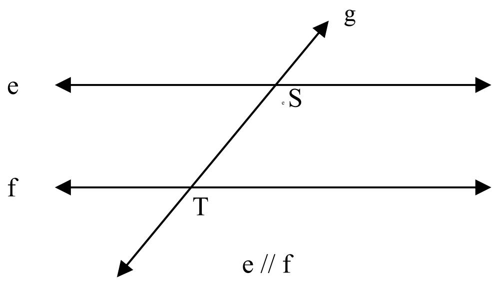
e // f // g



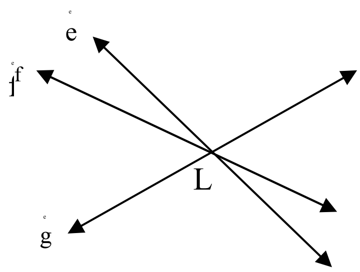
e = f
g // e
g // f



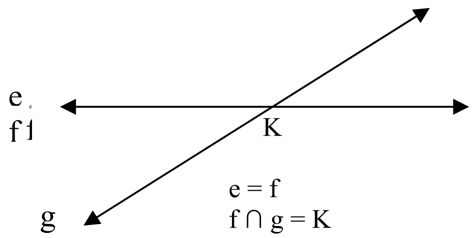
$e \cap f = R$
$f \cap g = P$
$e \cap g = S$



e // f
$e \cap g = S$
$f \cap g = T$



$e \cap f \cap g = L$

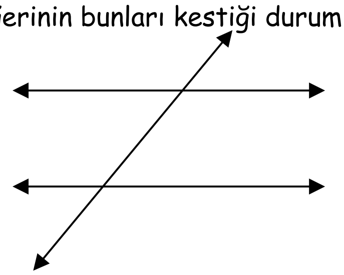


e = f
$f \cap g = K$
$e \cap g = K$

3. Öğrencilerin bu durumları defterlerine çizmeleri için süre verilir.

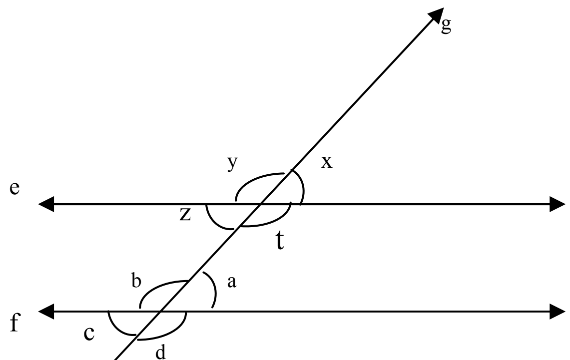
GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen "sınıfta 20 kişinin 2 tane keman teli (nin donuk imgesini) oluşturmasını istiyorum" der. Bu tellerin kemanda durdukları şekilde durmaları gerektiğini söyler. "Keman telleri nasıl duruyor" diye sorar. Öğrencilerden bu tellerin paralel durduklarını fark etmeleri beklenir. Daha sonra öğretmen sınıftaki diğer öğrencilerin bu keman teli üzerindeki keman yayı olmalarını ister. Oluşan şeklin neye benzediğini sorar.
Öğrencilerin yukarıda da oluşturdukları iki doğrudan ikisinin birbirine paralel diğerinin bunları kestiği durum olduğunu fark etmeleri beklenir.



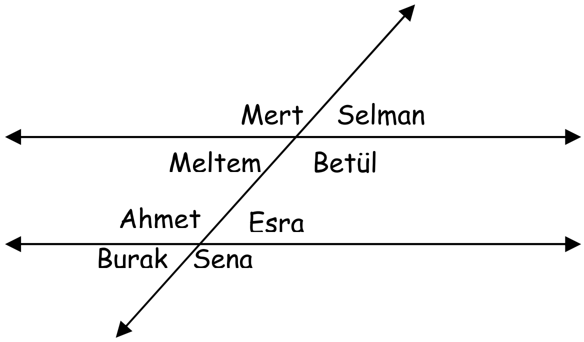
2. Oluşan bu şekil tebeşirle yere çizilir. Öğrencilerin doğrular üzerinde durmalarına gerek kalmaz. Öğretmen flashback tekniğini kullanarak "Şimdi bu şekil üzerindeki ters açıları söyleyelim. Ters açıların ölçüleri nasıldı? "Hemen bir ters açı oluşturup özelliğini hatırlayalım" der. Geçen derste yapılan makas modelini 4 öğrencinin canlandırmaları sağlanır. Daha sonra ters açıların ölçülerinin birbirine eşit olduğu söylenir.

3. Tahtaya iki paralel doğru ve bunları kesen bir doğru çizildikten sonra ters açıların ölçülerinin eşit olduğu aşağıdaki gibi yazılır.



s(y)=s(t)
s(a)=s(c)
s(x)=s(z)
s(b)=s(d)

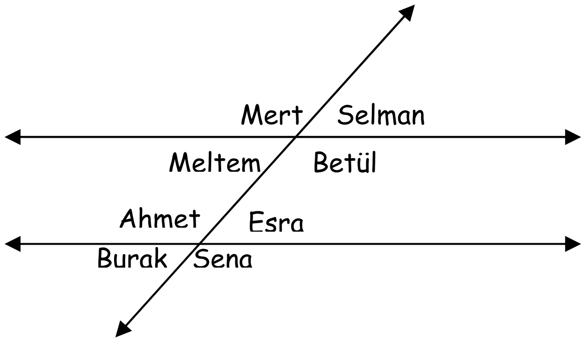
4. Öğretmen "şimdi sekiz kişi gelip bu açıların köşelerinde dursun. Bu sekiz kişinin dikkat etmesi gereken şey sırtlarını açının köşesine dönmek" der. Öğrencilerin köşelere yerleşmesi için gerekli süre verilir.



5. Öğrenciler yukarıdaki şekilde olduğu gibi açıların köşelerine yerleştikten sonra, öğretmen "Aynı yöne bakanlar kimler?" der. Öğrencilerin cevaplandırmaları beklenir. Sınıfın durumuna göre pencereye doğru bakanlar, askıya doğru bakanlar, kapıya doğru bakanlar vs. şeklinde cevaplar alına bilir. (Bu şekilde Ahmet ve Mert, Meltem ve Burak, Esra ve Selman, Betül ve Sena) "Şimdi aynı yönlere bakanların bulunduğu açıların ölçülerine bakalım." Öğrencilerin sınıftaki büyük açı ölçerlerle bu açıların ölçülerinin birbirine eşit olduğunu bulmaları sağlanır. Bu açılara ne isim verileceği sorulur. Aynı yöne bakıyor olmalarını hatırlatacak bir isim verilmesi gerektiği üzerinde durulur. Öğretmen "Aynı yönlere bakan ölçüleri eşit olan bu açılara YÖNDEŞ açılar denir" der ve tahtaya yöndeş açının tanımı ve şekildeki yöndeş açıları yazar.

6. Öğretmen öğrencilerden sınıfta donuk imgeyle 2 yöndeş açı oluşturmalarını ister. Bu açıları oluşturan gruplara "Yöndeş açıların ölçüleri nasıldır? Yöndeş açılar nasıl oluşur?"diye sorulur. Öğrencilerin yöndeş açının iki paralel doğruyu bir doğru kestiğinde oluşan aynı yönlere bakan açılar olduğunu düşünebilmeleri beklenir. Öğretmen "İki doğruyu bu doğrulara paralel olmayan üçüncü bir doğru kestiğinde oluşan açılardan aynı yöne bakanlarına yöndeş açılar denir. Eğer doğrulardan ikisi paralelse yöndeş açıların ölçüleri birbirine eşittir" der ve tahtaya yazar.

s(y)=s(b), s(x)=s(a), s(t)=s(d), s(z)=s(c)



7. Öğretmen "Bu şekilde hangi arkadaşlarımız iç tarafta duruyorlar" diye sorar. Bu öğrencilerin durdukları açıların ne gibi özellikleri olduğunu sorar. Öğrencilerden bu açıların iç tarafta olma özelliğini fark etmeleri beklenir. Daha sonra öğretmen "aynı şekilde dış tarafta kalan arkadaşlarımızı söyleyelim." der. Bu öğrencilerin durdukları açıların ne gibi özellikleri olduğunu sorar. Öğrencilerden bu açıların dış tarafta olma özelliğini fark etmelerini bekler.

8. Öğretmen "Şimdi Mert ve Sena'nın durumunu düşünelim; Selman ve Burak'ın durumunu düşünelim; bunlar yöndeş mi? "der. Öğrencilerden hayır cevabını beklenir. "Bu arkadaşlarınız birbirlerini görüyorlar mı? Birbirlerine göre nasıl durmuşlar?" diye sorar. Birbirlerine göre TERS cevabı beklenir. Bu açılara ne isim verileceği üstünde tartışılır. Öğretmen bu açıların iç tarafta mı yoksa dış tarafta mı yer aldıklarını sorar. Öğrencilerden dış tarafta cevabı beklenir. Öğretmen "o zaman; Mert ve Sena'nın; Selman ve Burak'ın gösterdikleri açılara DIŞ TERS AÇILAR ismi verebiliriz " der ve tahtaya yazar.

9. Öğretmen "Acaba Mert'in açısı mı büyük Sena'nın açısı mı? Selman'ın açısı mı büyük, Burak'ın açısı mı?" diye sorar. Öğrencilerden sınıftaki açı ölçeri kullanarak bu açıları ölçmeleri ve açıların ölçüsünün eşit olduğunu bulmaları beklenir. Öğretmen "Bunlar neden eşit olabilir?" diye sorar. Daha sonra eğer buradaki gibi oluşturan doğrulardan iki tanesi birbirine paralelse, dış ters açıların ölçülerinin eşit olduğunu söyler ve bu özelliği ve aşağıdaki bilgiyi tahtaya yazar.
y ve d ile c ve x açıları dış ters açılardır.
s(y) = s(d), s(c) = s(x)

10. Öğretmen "Sena ve Selman'ın açılarına dış ters açı diyebilir miyiz? Neden?" diye sorar. Dış ters açıların özellikleri tekrarlanır.

11. "Şimdi de Betül ve Ahmet'in gösterdikleri açıya bakalım. Meltem ve Esra'nın gösterdiği açıya bakalım. "Bu açılar yöndeş mi?" "Dış ters mi?" "İçteler mi, dıştalar mı?" diye sorar. Bu açıların nasıl isimlendirilebileceği tartışılır. "Bu şekildeki açılara da iç ters açılar diyoruz. Çünkü içte yer almışlar ve kesenin ters yönündeler." der. Tahtaya buradaki iç ters açılar yazılır.

12. Öğretmen "Acaba Betül'ün açısı mı büyük, Ahmet'in mi? Meltem'in açısı mı büyük Esra'nın mı?" diye sorarak iç ters açıların ölçülerini karşılaştırmalarını ister. Öğrencilerin açıları açı ölçer ile ölçmeleri ve dış ters açıların ölçülerinin birbirine eşit olduğu bulmaları beklenir. Öğretmen eğer buradaki gibi oluşturan doğrulardan iki tanesi birbirine paralelse iç ters açıların ölçülerinin eşit olduğunu söyler ve bu özelliği ve aşağıdaki bilgiyi tahtaya yazar.
z ve a ile ve b açıları iç ters açılardır.
s(z) = s(a), s(t) = s(b)

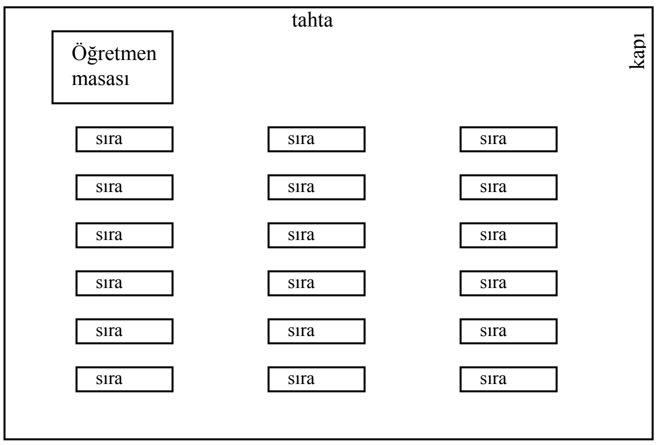
13. Öğretmen "Betül ve Esra'nın oluşturdukları açılara bakalım. Bunlar dış ters olabilirler mi?" diye sorar. Cevap üzerinde tartışılır.

14. Öğretmen “Şimdi önceki dersteki etkinlikte olduğu gibi sizler televizyon programı yapımcısısınız. Her bir grubun yöndeş, iç ters, dış ters açılar ile ilgili olarak televizyonda yayınlanacak bir program hazırlamasını istiyorum. Bende hazırladığınız TV programını değerlendireceğim ve uygun bulursam sahip olduğum TV kanalına satın alacağım. Bunun için 10 dakika süreniz var” der ve öğrencilere hazırlanmaları için süre verilir.

SONUÇ ETKİNLİKLERİ

1. Öğrencilerin hazırladıkları TV programını sunmaları için süre verilir.

DERS PLANI 3
ÜNİTE 5 AÇILAR VE ÇOKGENLER
HEDEF 3: Üçgenin yardımcı elemanlarını kavrayabilme
D1. Verilen bir üçgenin kenarlarını ve açılarını sembol kullanarak yazma
D2. Verilen bir üçgenin yüksekliklerini gösterip özelliğini söyleme
D3. Verilen bir üçgenin açıortaylarını gösterip özelliğini söyleme
D4. Verilen bir üçgenin kenarortaylarını gösterip özelliğini söyleme
HEDEF 4: Üçgenin yardımcı elemanlarını çizebilme
D1. Verilen bir üçgenin, belirtilen kenarına ait yüksekliğini çizme
D2. Verilen bir üçgenin, belirtilen kenarına ait kenarortayını çizme
D3. Verilen bir üçgenin, belirtilen kenarına ait açıortayını çizme
Süre: 1 ders saati
Materyal: Örümcek adamdan gelen mektup
Kullanılan drama teknikleri: mektuplar, rol içinde yazma (çizme)
Sınıf yerleşim planı:

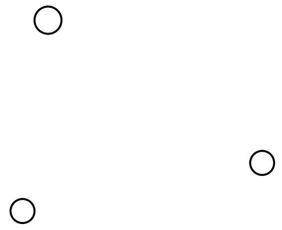


GİRİŞ ETKİNLİKLERİ

"Toprağa atılan bir tohum olduğunuzu düşünün. Topraktan su ve besin alıyorsunuz ve yavaş yavaş büyüyorsunuz. Yavaşça minik dal vermeye başladınız, bu dal yavaşça büyüyor, büyüyor, büyüyor. Toprağın üstüne çıkıyorsunuz. Şimdi minik bir fidansınız. Topraktan su ve besin almaya devam ediyorsunuz. Güneş büyümenize yavaşça yardım ediyor. Dallarınız uzuyor, uzuyor, uzuyor. Şimdi ılık bir rüzgar esmeye başladı, rüzgarı gövdenizde ve dallarınızda hissediyorsunuz. Kökleriniz ile topraktan su içmeye devam ediyorsunuz. Dallarınıza geveze kuşlar konuyor. Gövdenizde oluşan bir oyuğa bir sincap ailesi yuva yapıyorlar ve kışı gövdenizde geçiriyorlar. Yine ılık bir rüzgar esmeye başladı."

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen "Şimdi üç tane ağacımız var" der. 3 kişinin sınıfın ortasında ağaç olmasını ister.



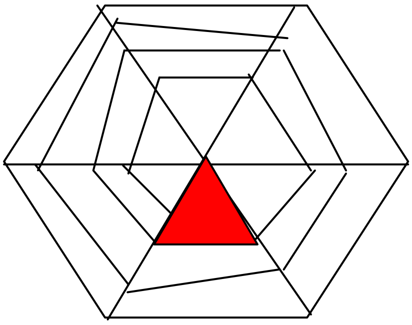
2. "Bu üç ağaç kaç değişik şekilde bulunabilir?" diye sorar. Bu üç noktanın birbirine göre doğrusal olan ve olmayan konumları üzerinde konuşulur. "Bu üç ağacın etrafını çevreleyeceksiniz. Nasıl çevrelersiniz?" Öğrencilerden "lastiklerle, iplerle" cevabı beklenir.

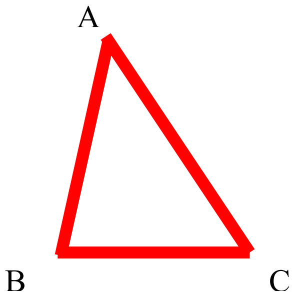
3. Öğretmen ağaçların sınıfa daha önce getirilmiş iplerle çevrilmesini sağlar. "Nasıl bir şekil oluştu?" diye sorar. Burada ağaçlar ve onları çevreleyen ip ile ilgili olarak konuşulur. Öğrenciler daha önceden üçgen kavramını öğrendikleri için "üçgenin köşeleri" ve "üçgenin kenarları" terimlerini kullanmaları beklenir. Bu terimlerin kullanımlarında hata varsa düzeltilir. Kenarları doğrusal olmayan üç kenarlı şekiller oluşturulup bunların üçgen olarak adlandırılıp adlandırılamayacağı sorulur. Tahtaya üçgen çizilir. Kenarları ve köşeleri üzerinde konuşulur, şekil üzerinde adlandırılır.

4. Öğretmen "Şimdi oluşan üçgeni tebeşirle yere çizelim" der ve yere üçgen çizilir. "Üçgenin bir köşesinden karşıdaki kenara yürümek istiyorsunuz. Ama çok yorgunsunuz o yüzden en kısa yolu seçip kısa zamanda karşı kenara varmak istiyorsunuz. Yürüyeceğiniz yol nasıl olmalı?" diye sorar. Öğrencilerin en kısa yolun kenara dik olan yol olduğu yani yükseklik olduğu bulmalarını bekler.

5. Öğretmen "şimdi hep birlikte bir üçgen ve bu üçgene ait yüksekliklerin donuk imgesini oluşturmanızı istiyorum. Öğrenciler şekli oluşturduktan sonra yüksekliklerin kenarlara dik olması üzerinde tekrar konuşulur.

6. Öğretmen öğrencilere "elimde sizlere gelmiş bir mektup var" diyerek, elindeki zarfı gösterir. Zarfı öğrencilere gösterdikten sonra açması ve okuması için bir öğrenciye verir. Zarfın üstünde 7-... sınıfına Örümcek Adam'dan geldiği yazmaktadır. İçerisinde a) üzerinde aşağıda görülen bir kısmı kırmızı ile boyanmış örümcek ağı bulunan 40 cm x 40 cm boyutlarında bir kağıt b) Üzerinde örümcek ağındaki koyu renkli kısmın çizili olduğu kağıtlar c) Örümcek adamın yazdığı mektup bulunmaktadır.

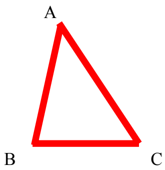




Örümcek adamın mektubu:

Merhaba Sevgili 7-.. öğrencileri,

Sizin üçgenler konusunda oldukça bilgili olduğunuzu öğrendim. Ördüğüm ağın ve bu ağın üçgen şeklindeki parçasının resmini sizlere gönderiyorum.



Ağın üçgen şeklindeki kısmı ile ilgili bir sorunum var. Benim evim üçgenin A köşesinde, sevgilim Mary Jane'nin evi bu üçgenin a kenarında. Benim evimden Mary Jane'nin evine giden yol A köşesindeki açının tam ortasından geçiyor. Fakat ben evimden Mary Jane'nin evine giden yolu kaybettim. A köşesindeyken Mary Jane'nin evine gitmek için izlemem gereken yolu çizerseniz, çok çok çok mutlu olacağım. Bu işi sınıfta 4'er kişilik gruplara ayrılarak yapmanızı istiyorum. Size üçgenin kopyalarını gönderiyorum. Şimdiden teşekkürler...

Örümcek Adam

7. Örümcek adamın mektubundan çıkan üzerinde büyük örümcek ağı resmi olan kağıt tahtaya asılır. Mektup okunduktan sonra öğretmen sınıfın 4erli gruplara ayrılmasını sağlar. Her gruba örümcek adamın gönderdiği zarftan çıkan üzerinde üçgen çizili olan kağıtlar verilir. Gruplara örümcek adamın istediği çizimin yapılması için yeterli süre verilir.

8. Gruplar çizimlerini bitirdikten sonra öğretmen "Siz çizimleriniz yaparken örümcek adam bir zarf daha gönderdi" der. Örümcek adamdan gelen ikinci zarfı açar ve çıkan mektubu okur. Mektubun ilk kısmında örümcek adam; "Eğer evim A köşesinde değil de B köşesinde, Mary Jane 'nin evi b kenarında olsaydı ve benim evimden Mary Jane'nin evine giden yol B köşesindeki açının tam ortasından geçiyor olsaydı, bu durumda benim evimden Mary Jane'nin evine giden yolu çizer misiniz?" yazmıştır. Öğretmen bu çizimin yapılması için yeterli süreyi verir.

9. Öğrenciler çizimlerini bitirdikten sonra, öğretmen örümcek adamdan gelen mektubun ikinci kısmını öğrencilere okur; "Eğer evim C köşesinde olsaydı ve Mary Jane 'nin evi c kenarında olsaydı ve benim evimden Mary Jane'nin evine giden yol C köşesindeki açının tam ortasından geçiyor olsaydı, benim evimden Mary Jane'nin evine giden yolu çizer misiniz?". Öğretmen bu çizimin yapılması için yeterli süreyi verir.

10. Öğretmen mektubun son kısmını öğrenciler okur: "Bu üç çizimin sonunda nasıl bir şekil elde ettiniz?" Öğrencilerden bu üç çizginin bir noktada kesiştiği cevabı beklenir. Cevap alındıktan sonra mektubun son kısmı okunmaya devam edilir; "Burada köşedeki açıyı iki eş parçaya bölen doğru parçalarını çizdiniz. Üçgende bir açıyı iki eş açıya bölen ve karşı kenarla birleşen doğru parçasına AÇIORTAY denir". Sınıfta açıortay üzerine konuşulur ve öğretmen son kısımdaki açıortay tanımını tahtaya yazar.

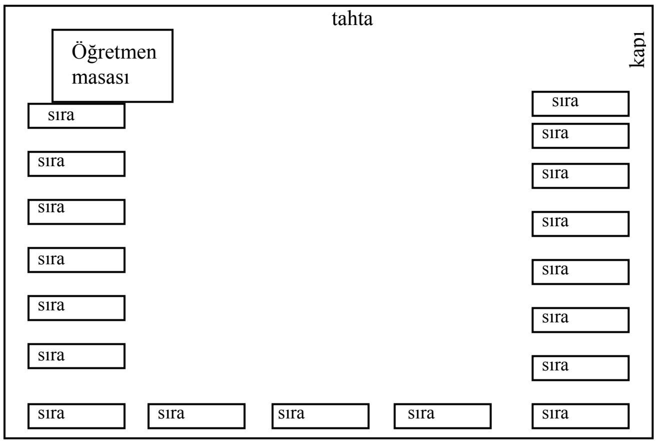
11. Öğretmen "Örümcek adam A köşesinde durmaktadır, ve karşı kenarın tam ortasına gitmek istemektedir. Örümcek adamın gideceği yolu çizin. Örümcek adam B köşesinde dursaydı ve karşı kenarın tam ortasına gitmek isteseydi izleyeceği yolu çiziniz. Eğer Örümcek adam C noktasında olsaydı ve bu kez karşı kenarın tam ortasına gitmeye karar verseydi izleyeceği yol nasıl olurdu? Çiziniz. Örümcek adamın izleyeceği bu üç yolu çizdiğimizde ne bulduk?" der.

12. Öğretmen ne isim verilebileceğini sorar, isimde kenarın ortası ilişkisinin olması gerektiği üzerinde durur. "Bir köşeyle tam karşısındaki kenarı birleştiren kenara KENARORTAY adı verilir" der ve bu tanımı tahtaya yazar.

SONUÇ ETKİNLİKLERİ

1. Öğretmen öğrencilere "Siz bir önceki etkinliği yapmaktayken örümcek adamdan bir mektup daha geldi" der ve gelen mektubu okur; Herkes defterine 3 tane üçgen çizsin. İlkinde o üçgene ait bütün kenarortayları, ikincisinde tüm açıortayları, üçüncüsünde ise tüm yükseklikleri gösterin"

DERS PLANI 4
ÜNİTE 5 AÇILAR VE ÇOKGENLER
HEDEF 5: Üçgenin kenarları ve açıları arasındaki bağıntıları kavrayabilme
D1. Bir üçgenin iki kenarının toplamı veya farkı ile üçüncü kenarının uzunluğu arasındaki ilişkiyi söyleyip yazma
D5. Bir dik üçgenin hipotenüsünün uzunluğu ile bir dik kenarının uzunluğu arasındaki ilişkiyi söyleyip yazma
Süre: 1 ders saati
Materyal: Her grup için çalışma kağıdı, belli uzunluklarda kesilmiş pipetler, ip, farklı iki renkte fosforlu kalemler
Kullanılan drama teknikleri: Uzman rolü, toplantı düzenleme, öğretmenin role girmesi
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

Şimdi 1'den 10'a ya da 10'dan 1'e kadar ritmik olarak sayacağız. Şimdi yeni yıla girerken saniyeleri sayıyoruz. Cebimizde düşsel olarak bulunan bozuk paraları sayıyoruz. Bir boks maçında hakemsiniz, son 10 saniyeyi sayıyorsunuz. Step yapıyoruz, sayalım. Evinize kalabalık misafir gelmiş, gelen konukları hissettirmeden gözlerinizle sayıyorsunuz. Dersin son dakikası, sözlüye kalkmak üzeresiniz ve zilin çalmasını beklerken saniyeleri sayıyoruz. Son olarak uzaya fırlatılacak olan roketin kalkışından önceki saniyeleri sayıyorsunuz (Üstündağ, 2003).

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen bu etkinlikte 4 er kişilik gruplar halinde çalışacaklarını söyler. "Ben NASA'nın gönderdiği bir temsilciyim ve sizler NASA'nın görevlendirdiği bilim adamlarısınız. NASA diyor ki "Yeni bir gezegen bulduk. Bu gezegende sadece üçgen şeklindeki evler içinde yaşanabiliyor. Bu gezegene seyahat etmek için orada içinde yaşayabileceğiniz üçgenlere ihtiyaç var. Siz bilim adamlarından orada içinde yaşamak üzere üçgenler üretmenizi istiyoruz. Bu iş bize çok kolay gibi göründü. Ama biraz uğraşınca işin içinden çıkamayacağımızı anladık. Örneğin kenarları 2, 3, 13 cm. olan bir üçgen çizilebilir mi? Bazı arkadaşlarımız bunun çizilemeyeceğini iddia ettiler ama neden çizilemeyeceğini bir türlü açıklayamadılar. Şimdi bu işi size bırakıyoruz. Bu işi

başarmak için aşağıdaki tablodan ve sizlere verilecek pipet ve iplerden yararlanabilirsiniz. Çalışmanızı bitirdikten sonra grupların buldukları sonuçları sırayla NASA'nın bir görevlisi olan bana sunmanızı istiyorum " der.

Kenar Uzunlukları	Üçgen Oluşturup Oluşturmadığı
2, 3, 13	
4, 5, 7	
6, 1, 9	
4, 3, 10	
8, 5, 4	
6, 2, 1	
14, 9, 4	
7, 7, 8	
4, 4, 10	
3, 4, 5	
1, 2, 3	

2. Öğrencilerin her seferinde belli uzunluklarda kesilmiş ve uzunlukları üzerlerinde yazan 3 pipetin içine ip geçirerek, kenar uzunlukları o 3 sayı olabilecek bir üçgen oluşturup oluşturulamayacağını tespit etmesi ve uygun bir şekilde tabloyu doldurması beklenir.

3. Bu şekilde tablo doldurulduktan sonra öğretmen öğrencilerin üçgen oluşabilecek durumları sarı fosforlu kalemle, oluşturamayacak durumları ise mavi fosforlu kalemle boyamalarını ister.

4. Öğrencilerden bu farklı fosforlu renklerle boyalı satırlar arası ilişkiyi bulmaları beklenir.

SONUÇ ETKİNLİKLERİ

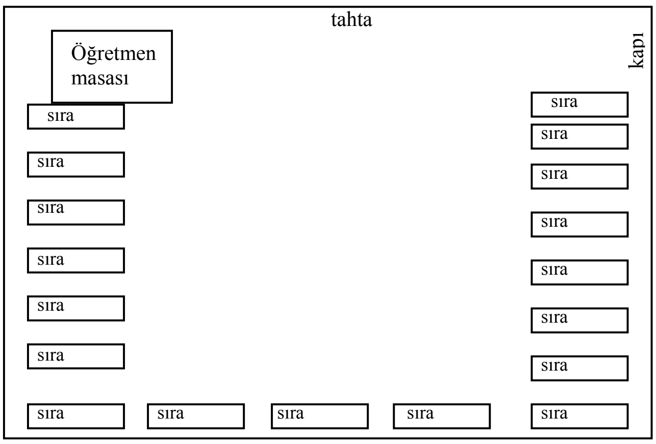
1. Öğrencilerin sonuçlarını gruplar halinde sunmaları için süre verilir. Burada öğrencilerin üçgenin kenar uzunlukları arasındaki "iki kenarın uzunluğunun toplamı, üçüncü kenarın uzunluğundan büyük; iki kenarın uzunluğu farkı ise, üçüncü kenarın uzunluğundan küçüktür" ilişkisini bulması beklenir.

2. Öğretmen üçgenin kenar uzunlukları arasındaki "iki kenarın uzunluğunun toplamı, üçüncü kenarın uzunluğundan büyük; iki kenarın uzunluğu farkı ise, üçüncü kenarın uzunluğundan küçüktür" bağıntısını tahtaya yazar.

3. Öğretmen öğrencilerden ödev olarak aşağıdaki listedeki verilerle üçgen çizilip çizilemeyeceğini bulmalarını ister.

a. 3, 4, 7 b. 3, 2, 6 c. 8, 18, 8 d. 1, 6, 6 e. 4, 3, 5
f. 17, 3, 16 g. 4, 7, 8 h. 50, 20, 30 ı. 42, 23, 20 k. 15, 20, 16

DERS PLANI 5
HEDEF 5: Üçgenin kenarları ve açıları arasındaki bağıntıları kavrayabilme
D2. Bir üçgende, bir köşedeki iç ve dış açılar arasındaki ilişkiyi söyleyip yazma
D3. Bir üçgende, bir köşedeki dış açı ile kendisine komşu olmayan iki iç açı arasındaki ilişkiyi söyleyip yazma
D4. Bir üçgenin kenar uzunlukları ile bu kenarlar karşısındaki açıların ölçüleri arasındaki ilişkiyi söyleyip yazma
HEDEF 6: Üçgenlerde açı hesaplayabilme
D1. Bir üçgenin iç açılarının ölçüleri toplamını bulup yazma
D2. Bir üçgenin dış açılarının ölçüleri toplamını bulup yazma
D3. Bir üçgenin bir köşesindeki iç veya dış açılardan birinin ölçüsü verildiğinde, diğer açının ölçüsünü bulup yazma
D4. Bir üçgenin iki iç açısının ölçüsü verildiğinde, üçüncü iç açısının ölçüsünü bulup yazma
D5. Bir üçgenin bir dış açısının ölçüsü ile farklı köşesindeki bir iç açısının ölçüsü verildiğinde, diğer iç açılarının ölçülerini bulup yazma
D6. Bir üçgenin herhangi iki açısının ölçüsü verildiğinde, diğer iç veya dış açıların ölçülerini bulup yazma
D7. Tepe açısının veya taban açılarından birisinin ölçüsü verilen ikizkenar üçgenin diğer açılarının ölçülerini bulup yazma
D8. Dar açılarından birinin ölçüsü verilen bir dik üçgenin diğer dar açısının ölçüsünü bulup yazma
D9. Üçgenin açıları arasında verilen bağıntılardan yararlanarak, istenilen açıların ölçülerini bulup yazma
Süre: 1 ders saati
Materyal: ip
Kullanılan drama teknikleri: Mektuplar, donuk imge
Sınıf yerleşim planı:



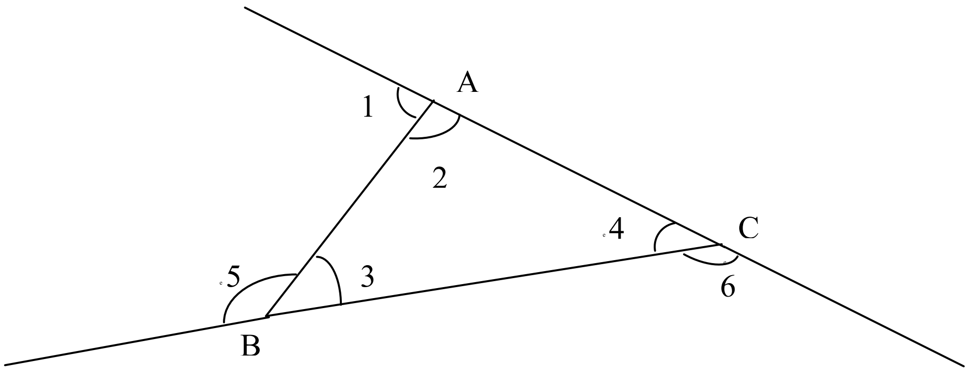
GİRİŞ ETKİNLİKLERİ
Öğretmen "Şimdi herkes gözlerini kapatsın. Bir çiçek olduğunuzu düşünün. Renginizi, boyunuzu, yapraklarınızı, kokunuzu... Sizinle aynı ya da farklı tür arkadaşlarınız olduğunu düşünün. Bu arkadaşlarınızla bir aradasınız. Etrafınızda bir sürü çiçek var.

Yüzlerce çiçek görüyorsunuz. Hepiniz kocaman bir bahçenin içindesiniz. Hava oldukça sıcak. Susamaya başladınız. Birilerinin gelip sizi sulamasını istiyorsunuz. Birden bir fıskiye sesi duymaya başlıyorsunuz. Artık suya kavuşacağınız için çok sevinçlisiniz. Su geldi. Suyu kana kana içiyorsunuz. Suyunuzu içtikten sonra gözlerinizi açabilirsiniz"

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen sınıfı 4 gruba ayırır. Her gruba üzerinde aşağıdaki şeklin olduğu bir kağıt verir.

"Elinizdeki kağıtta bir arazinin kuşbakışı görüntüsü var. Bu arazide üçgen şeklinde bir parça çevrelenmiştir. Arazinin iç ve dış köşelerindeki açıları sulayan fıskiyeler görülmektedir. Örneğin burada 1 numaralı fıskiye üzerinde bulunduğu açıyı sulamaktadır, komşu açıda bulunan 2 numaralı fıskiye ise üçgenin A köşesindeki açıyı sulamaktadır " der. Bu şeklin gruplar içinde canlandırılmasını ister.



Ardından aşağıdaki soruları sorar;
1 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?
2 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?
3 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?
4 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?
5 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?
6 numaralı fıskiye üçgenin hangi tarafını sulamaktadır?

2. Bu fıskiyelerin suladığı açılara hangi isimler verilebileceğini sorar. Öğretmen "Burada 1, 5 ve 6 numaralı fıskiyelerin suladığı açılara üçgenin dış açıları, 2, 3 ve 4 numaralı fıskiyelerin suladıkları açılara üçgenin iç açıları adı verilmektedir" açıklamasını yapar. Öğrencilere "Burada üçgenin dış açılarını sulayan fıskiyelerin sulama açılarının toplamı kaç derecedir? Ölçmeden bulabilir misiniz?" diye sorar. Öğrencilerden 180° cevabını bulmaları beklenir. Bunun sebepleri üstünde konuşulur.

3. Öğretmen gruplara açıklama yapar; "Gördüğünüz şekildeki A köşesinde iki tane fıskiye vardır. Fıskiyelerden birincisi üçgenin dışındaki 1 ile işaretlenmiş olan açıda yer almaktadır. Diğer fıskiye yani 2 numaralı fıskiye ise yine A köşesinde fakat bu kez üçgenin içinde yer almaktadır. Bu iki fıskiye üçgenin kenarı ile

birbirinden ayrılmıştır. 1 fıskiyesi üçgenin dışındaki açının bulunduğu bölgeyi, 2 fıskiyesi ise üçgenin içini sulamaktadır."

4. Gruplardan kağıt üzerinde gördükleri şekli oluşturmaları istenir. Öğretmen "Şimdi her grup 1 ve 2 numaralı fıskiyeler yerine geçecek iki kişi seçsin. Bu fıskiyeler belli bir açı ile bir bölgeyi suluyorlar. Şimdi 1 ve 2 fıskiyeleri olan arkadaşlarınız bu fıskiyeler bahsedilen durdukları köşeden o bölgeyi nasıl sulayacaklarını göstersinler" der. Sonra tek tek grupların oluştukları durumlara bakılır.

5. Öğretmen "1 fıskiyesi 60°lik bir açı ile sulama yapmakta ise 2 fıskiyesi kaç derecelik bir açı ile sulama yapmaktadır?" diye sorar. Öğrencilerden 120° cevabı beklenir. Neden 120° olması gerektiği ve komşu bütünler açıların özellikleri üzerinde konuşulur.

6. Öğretmen sırayla şu soruları öğrencilere sorar: "1 fıskiyesinin sulama açısı mı daha büyüktür yoksa 3 fıskiyesinin mi? 1 fıskiyesinin sulama açısı mı daha büyüktür yoksa 4 fıskiyesinin mi? Yukarıdaki durumda 2, 3 ve 4 numaralı fıskiyelerin sulama açılarının toplamı kaçtır?"Cevaplar üzerinde konuşulur. Üçgende bir dış açının kendisine komşu olmayan iç açılardan büyük olduğu söylenir.

7. Öğretmen üçgen şeklindeki bahçenin kenar uzunluklarını ölçerek büyükten küçüğe sıralamalarını ister. Öğrencilerden bu işi iple yapmaları beklenmektedir.

8. Öğretmen öğrencilerden üçgen şeklindeki bahçenin iç açılarını küçükten büyüğe sıralamalarını ister.

9. Öğretmen kenar ve iç açıların sıralaması arasında bir nasıl bir ilişki olduğunu sorar. Öğrencilerden kısa kenar karşısında en küçük açının, uzun kenar karşısında ise en büyük açının olduğunu bulmaları istenir. Öğretmen üçgende uzun kenar karşısında büyük açı, kısa kenar karşısında ise küçük açı olduğunu bulmaları beklenir.

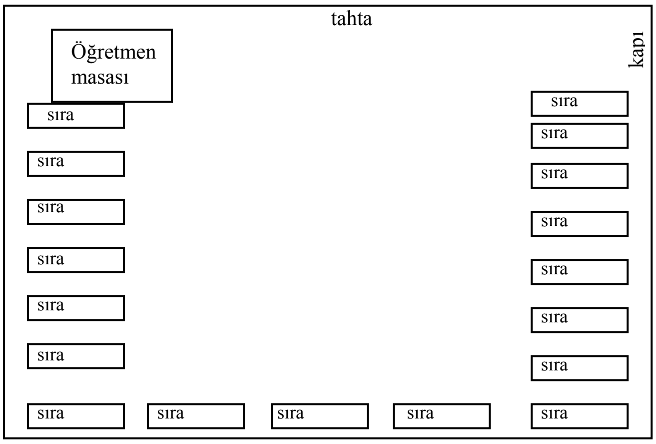
10. Öğretmen grupların her birine farklı uluslardan bir çocuğun fotoğrafını verir. Bu çocukların ismini ve hangi ulustan olduklarını söyler. Bu fotoğrafın 23 Nisan da Türkiye'ye gelen gruplardan çocuklara ait olduğunu söyler. Her gruptan kendilerine verilen fotoğraftaki çocuğa mektup yazmalarını ister. Bu çocukların ülkesinde üçgenler konusunun işlenmediği bilgisini verir. Mektupta bugünkü derste yapılanları anlatmalarını, üçgenin iç açılarının ölçüleri toplamı, dış açılarının ölçülerinin toplamı, bir köşedeki dış açı ile kendisine komşu olmayan iki iç arasındaki ilişki, üçgenin kenar uzunlukları ile bu kenarlar karşısındaki açıların ölçüleri arasındaki ilişki hakkında bilgi vermelerini ister. Öğrencilerin mektupları yazmaları için gereken süre verilir.

SONUÇ ETKİNLİKLERİ

1. Öğrencilerin yazdıkları mektuplar sırayla okunur. Grupların diğer grupların mektupları ile ilgili fikirleri sorulur.

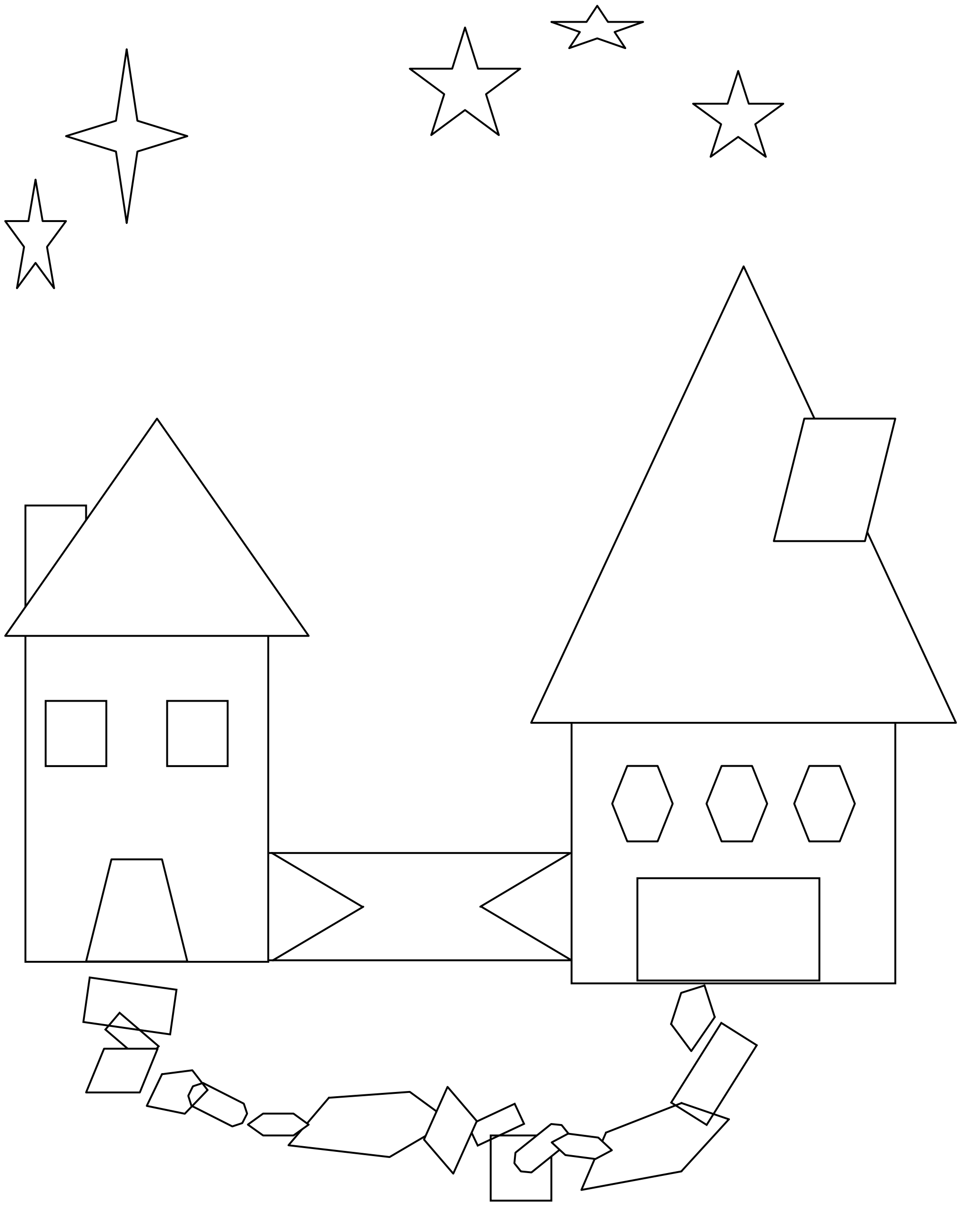
2. Öğrencilerle üçgende, bir köşedeki dış açı ile kendisine komşu olmayan iki iç arasındaki ilişki ve üçgenin kenar uzunlukları ile bu kenarlar karşısındaki açıların ölçüleri arasındaki ilişkiyi tekrarlanır.

DERS PLANI 6
HEDEF 7: Çokgenleri kavrayabilme
D1. Çokgeni örneklerle açıklama
D2. Verilen bir çokgeni adlandırarak söyleme
D3. Verilen bir çokgenin kenarlarını ve köşelerini sembol kullanarak yazma
D6. Düzgün çokgeni örneklerle açıklama
Süre: 2 ders saati
Materyal: 3 tane 3 metre uzunluğunda lastik,
Kullanılan drama teknikleri: Telefon görüşmesi, donuk imge
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

Öğrencilerin ikişerli gruplara ayrılmaları istenir. Her gruba üzerinde çeşitli çokgenlerden oluşan aşağıdaki resim ve kuru boya kalemleri verilir. Her ikili grubun resmi istedikleri gibi boyamaları istenir.



GELİŞTİRME ETKİNLİKLERİ

1. Sınıf 3 gruba ayrılır. Her gruba 3 metre boyunda uçları birleştirilmiş lastik verilir. Öğretmen "Bu lastiği kullanarak bir üçgen oluşturun" der. Oluşturulduktan sonra, "Kaç kenarı var?" "Kenarları nasıl?" "Kaç köşesi var?" "Köşeleri kim?" diye sorar.

2. Öğretmen "Dört kenarlı bir şekil oluşturun". Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl? (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?)" "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

3. Öğretmen "Dört kenarlı başka bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl?" (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?") "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

4. Öğretmen "Beş kenarlı bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl? (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?)" "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

5. Öğretmen "Beş kenarlı başka bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl?" (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?") "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

6. Öğretmen "Altı kenarlı bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl? (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?)" "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

7. Öğretmen "Altı kenarlı başka bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl?" (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?") "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

8. Öğretmen "Yedi kenarlı bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl? (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?)" "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

9. Öğretmen "Yedi kenarlı başka bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl?" (sadece iki tanesi

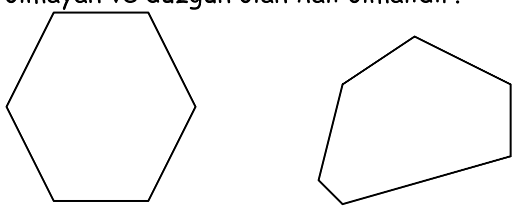
birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?") "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

10. Öğretmen "Sekiz kenarlı bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl? (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?)" "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

11. Öğretmen "Sekiz kenarlı başka bir şekil oluşturun" der. Oluşturulduktan sonra "Kaç kenarı var?" "Kenarları nasıl?" (sadece iki tanesi birbirine paralel?, hepsi aynı uzunlukta?, karşılıklı kenarlar birbirine paralel?, " "Kaç köşesi var?" "Köşeleri kim?" "İçine giren biri dışarı kaçabilir mi? (yani kapalı mı?") "Kaç tane açısı var?" "Açıları nasıl? (dik, dar, geniş)" "İsmini bildiğiniz bir şekle benziyor mu?" diye sorar.

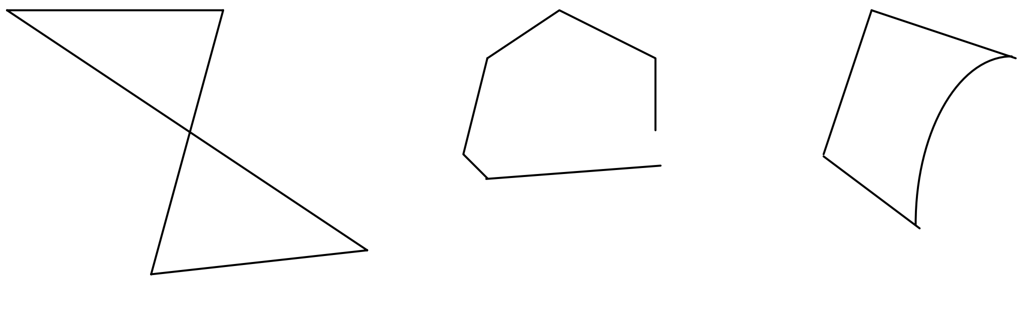
Bu etkinlikte öğrenciler yeni çokgenler oluşturdukça, oluşan çokgenin öğrencilere daha önceki yıllardan tanıdık olup olmaması dikkate alınarak o çokgenin sınıflandırılmasına ilişkin sorulara sorulur. Örneğin öğrenciler bir kare oluşturduklarında "Bu şekle kareden başka bir isim verilebilir mi? Bunun dikdörtgen olması mümkün mü? Dikdörtgen nasıl oluyordu? Buna aynı zamanda paralelkenar da diyebilir miyiz? Paralelkenarın özellikleri neydi?"

Her bir yeni şekil oluşturulduğunda tahtaya çizilir. Tahtaya çizilen şekillerin kenar ve köşe isimleri üzerinde konuşulur, yazılır. Tahtada aşağıdaki gibi aynı tür çokgenin düzgün olmayan ve düzgün olan hali olmalıdır.



12. Yukarıdaki gibi şekiller üzerine konuşulur. "Bunlara ne isim verelim?" "Çokgen ismi buldurulmaya çalışılır."

13. "Aşağıdaki şekilleri çokgen olarak adlandırabilir miyiz?"



14. “Bir şekli çokgen olarak adlandırmamız için hangi koşulların sağlanması lazım?”

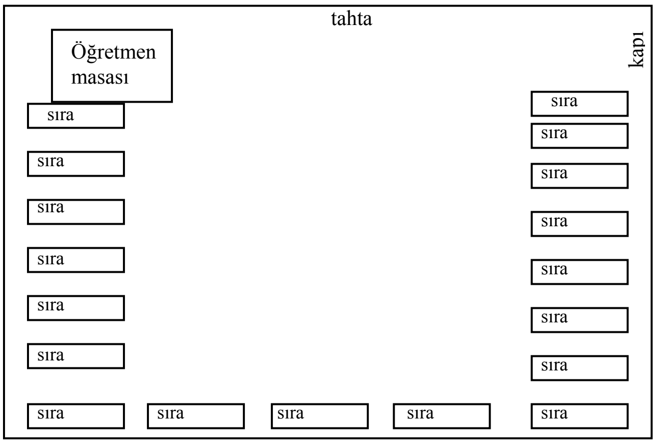
15. Öğretmen “şimdi sınıfta herkes bir arkadaşı ile eş olsun” der. Eşler kendi aralarında A ve B olarak adlandırılsınlar. A’lar hasta oldukları için bugünkü derse gelememişler. Akşam üzeri B’yi telefonla arayıp bugünkü matematik dersinde ne yaptıklarını ve neler öğrendiklerini soruyorlar. Eler de dersteki etkinliği özetleyip, çokgenin ne demek olduğunu örnekler vererek telefondaki arkadaşlarına anlatıyorlar. “ der. Daha sonra A ve B rol değiştirmesi söylenir ve aynı etkinlik tekrarlanır.

SONUÇ ETKİNLİKLERİ

1. Bir kaç tane örnek telefon konuşması sınıfça dinlenir ve üzerinde tartışılır.

2. Öğretmen “en az üçü doğrusal olmayan noktaları birleştiren doğru parçalarının meydana getirdiği kapalı düzlemsel şekillere çokgen” denildiğini tekrarlar.

DERS PLANI 7
ÜNİTE 5 AÇILAR VE ÇOKGENLER
HEDEF 7: Çokgenleri kavrayabilme
D4. Bir çokgenin bir köşesinin diğer köşelerle birleştirilmesinden elde edilecek üçgen sayısı ile çokgenin kenar sayısı arasındaki ilişkiyi söyleyip yazma
D5. Köşe ve kenar sayısı verilen bir çokgenin iç açılarının ölçümleri toplamını veren bağıntıyı söyleyip yazma
D7. Düzgün çokgenlerden; üçgenin, dörtgenin, beşgenin ve altıgenin iç açılarından her birinin ölçülerini veren bağıntıyı söyleyip yazma
Süre: 1 ders saati
Materyal: ip
Kullanılan drama teknikleri: Uzman rolü, rol içinde yazma
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

Bütün sınıf elele verip köşeleri olan bir şekil oluşturun. Şimdi elleri bırakalım omuz omuza köşeleri olan bir şekil oluşturalım. Şimdi yine omuz omuza köşeleri olan 2 tane şekil oluşturun. Elele köşeleri olan ve içiçe geçmiş 3 tane şekil oluşturun.

GELİŞTİRME ETKİNLİKLERİ

1. ".Turist olarak Amerika'da bulunuyorsunuz. Şu an Amerikan Savunma Bakanlığı binası Pentagon'un turistlere açık kısmında dolaşmaktasınız. Binaya 30 dakika içinde bir terörist saldırı yapılacağını öğreniyorsunuz. En kısa sürede binayı terk etmeniz gerekiyor. Binayı tek terk edebilme yolunuz binanın köşelerinde yer alan kapılar. Yalnız çok hassas bir şekilde korunan bu binanın kapısından dışarı çıkabilmek için kapıdaki görevlinin soracağı soruyu bilmeniz gerekiyor. Şu an tam köşedeki kapının eşiğindesiniz. Görevli size soruyu soruyor".

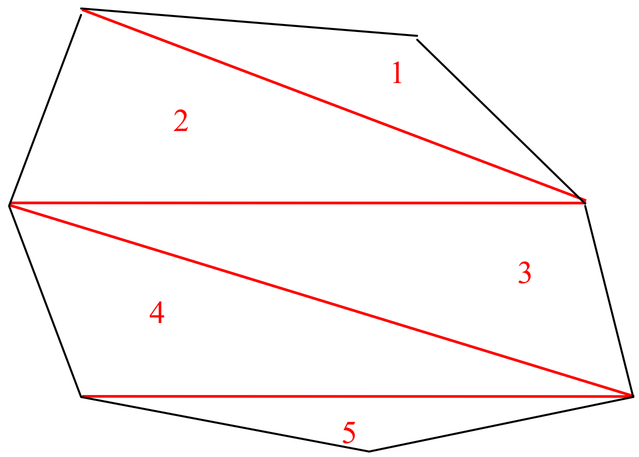
Öğretmen güvenlik görevlisi rolünde soruyu sorar:

"Bildiğiniz gibi bu binanın adı Pentagon yani beşgen. Binanın kesiti bir düzgün beşgen. Siz şimdi bu beşgenin tam köşesindesiniz. Size sorum şu, bu köşedeki açı kaç derecedir?"

2. Öğretmen soruyu sorduktan sonra yine güvenlik görevlisi rolünde sorunun cevabını bulmak için acele etmeleri gerektiğini, takıldıkları bir nokta olursa onlara yardım edebileceğini söyler. "Size yardımcı olabileceğini düşündüğüm 1 tane 3 metre uzunluğunda lastik ve not alıp hesaplama yapabilmeniz için kağıt ve kalem vereceğim" der. Öğrencilere gereken süre verilir.

3. Öğrenciler çalışmalarını bitirdikten sonra güvenlik görevlisine cevaplarını açıklamaları istenir.

(Eğer öğrenciler zorlanırlarsa aşağıdaki yönergelerle yardımcı olunabilir;
2. "Şimdi bu ipin içine girerek herhangi bir çokgen oluşturalım. " (Köşeleri öğrenci olacak.) Şimdi bu üçgenin içine size vereceğim iplerle üçgenler oluşturacaksınız. Bunun için koşul çokgenin içinde oluşturacağınız üçgenlerin KENARLARINDAN EN AZ BİRİNİN BU ÇOKGENİN KENARI OLMASI.



Bu şekilde kaç tane üçgen oluşturdunuz?

"Şimdi tahtaya şöyle bir tablo çiziyorum." Aşağıdaki tablo tahtaya çizilir.
"Bu tabloya oluşturduğumuz çokgen ve üçgenlerle ilgili bilgiyi yazalım." Bu şeklin iç açılarının ölçüsü kaç derece olabilir? Nasıl bulabiliriz."

A	B	C	D	E
Çokgenin kenar sayısı	Köşeler	İçinde kaç üçgen var?	Üçgenleri yazın	İç açılarının ölçüsü kaç derecedir?

Aynı şekilde başka çokgenler için aynı şeyler yapılır ve tablo doldurulur.
"A ve C kolonları arasındaki ilişki ne olabilir?"

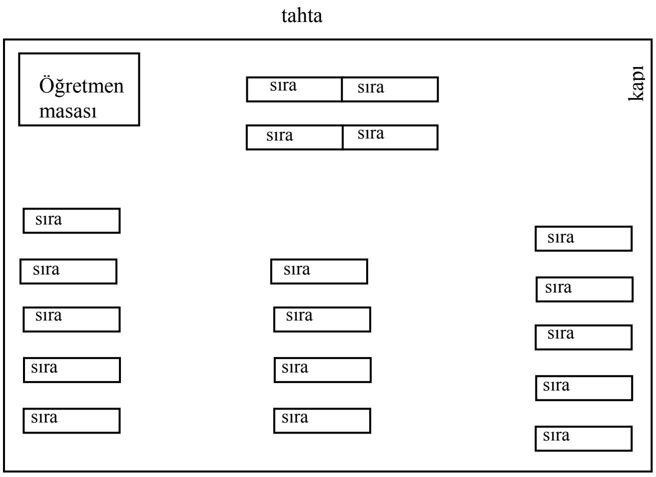
"C ve E kolonları arasındaki ilişki ne olabilir?"
"A ve E kolonları arasındaki ilişki ne olabilir?"

SONUÇ ETKİNLİKLERİ

1. Köşe ve kenar sayısı verilen bir çokgenin iç açılarının ölçümleri toplamını veren bağıntıyı tekrarlanır.

2. Düzgün çokgenlerin (beşgen, altıgen, yedigen, sekizgen, dokuzgen)iç açılarından her birinin ölçüleri bulunur.

DERS PLANI 8
HEDEF 8: Dörtgen, paralelkenar, dikdörtgen, eşkenar dörtgen, kare, yamuk, deltoid ile bunların elemanları arasındaki ilişkileri kavrayabilme
D1. Verilen bir dörtgenin, kenarlarını ve köşegenlerini adlarıyla söyleyip yazma
D2. Verilen bir dörtgenin kenar özelliklerini söyleyip yazma
D3. Verilen bir dörtgenin açı özelliklerini söyleyip yazma
D4. Verilen bir dörtgenin köşegen özelliklerini söyleyip yazma
D5. Yamuk çeşitlerini söyleyip yazma
Süre: 2 ders saati
Kullanılan drama teknikleri: TV programı, toplantı düzenleme, rol içinde yazma
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ
1. Öğretmen "Şimdi sınıfta hızlıca 5 tane kare oluşturun. Şimdi 1 kare 2 dikdörtgen oluşturun" der. Daha sonra sırayla 3 dikdörtgen/ 1 yamuk/ 1 kare/ 1 deltoid/ 2 paralelkenar oluşturmaları söylenir.

GELİŞTİRME ETKİNLİKLERİ
1. Öğretmen "Şimdi 4 gruba ayrılacağız. Her grup elimdeki zarflardan bir tanesini seçecek. Bu zarflarda sizin grubunuzun temsil ettiği dörtgen ülkesine ait şekiller ve size etkinlik boyunca gerekli olacak araç gereç bulacaksınız. Ülkenizi diğer ülkeler içerisinde çok iyi bir şekilde temsil etmek için yönergelere çok dikkatli bir şekilde uymanız, herhangi bir yanlışlık yapmamanız gerekiyor. Bunun yanında diğer ülkelerin temsilcilerinin söz ve davranışlarını çok dikkatli takip etmeniz ve eğer yanlışlıklar yaparlarsa not etmeniz gerekiyor." der.

2. Sınıf 4 gruba ayrılır. Gruplar kapalı zarflardan birini seçerler. Zarflarda PARALELKENAR; DİKDÖRTGEN, EŞKENAR DÖRTGEN ve KARE yazılıdır. Gruplara seçtikleri dörtgenin ülkesinin sahibi oldukları söylenir. Gruplara seçtikleri dörtgenle ilgili olarak bir paket verilir. Paketlerden grubun seçtiği zarfta adı yazan dörtgenin değişik kenar uzunlukları ve (uygunsa) değişik açı ölçülerine sahip çeşitli örnekleri,

dörtgenle ilgili çalışma yaprağı, açı ölçer, cetvel, büyük karton, renkli kağıt ve kalemler çıkar. Her gruba sınıfın bir köşesinde çalışma mekanı verilir. Bu mekanda grup üyeleri hep birlikte çalışma yapraklarındaki yönergeleri yerine getirirler.

ÇALIŞMA YAPRAĞI:

1. Bütün şekillerinizin köşelerine isim verin.

2.Bütün şekillerinizin kenarlarına isim verin.

3.Şekillerin kenar uzunluklarını ölçüp aşağıdaki tabloya yazın.

4.Şeklinizin kenar uzunlukları hakkında ne söylersiniz?

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Şekil no:	1. kenarının uzunluğu	2. kenarının uzunluğu	3. kenarının uzunluğu	4. kenarının uzunluğu
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5.Şekillerinizin açılarını ölçüp aşağıdaki tabloya yazınız.

6.Şeklinizin açıları hakkında ne söylersiniz?

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Şekil no:	1. açısının ölçüsü	2. açısının ölçüsü	3. açısının ölçüsü	4. açısının ölçüsü
1				
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7.Şeklinizin köşegenlerini çizin.

8.Köşegenlerinin uzunluklarını aşağıdaki tabloya yazın.

9.Şeklin köşegenleri hakkında ne söylersiniz?

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Şekil no:	Köşegenlerinin uzunlukları
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Şimdi bu etkinlikte şeklinize ait bulduğunuz özellikleri kısaca özetleyin (Kenarlar, açılar, köşegenler ile ilgili)
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3. Her grup çalışma yaprağını doldurduktan sonra, grupların her birine diğer gruplara ziyarete gidecekleri ve o ülkenin sınırlarından geçmek için ülkeyle ilgili bir takım bilgileri edinmeleri gerektiği, bu bilgileri not almaları gerektiği söylenir.

4. Gruplar sırayla birbirlerini konuk ederler ve birbirlerine giderler. Konuk giden grup gittiği ülkeyi tanımaya çalışır, Konuk gittiği ülkenin kendi için doldurduğu çalışma yaprağında yazdığı özellikler ile ilgili bilgiler edinir. Ardından kendini o ülkeye tanıtır. İki ülkenin elemanları iki ülkeye ait ortak ve farklı özellikleri bulurlar ve not ederler.
(Karışıklık olmaması için
1. kare grubu dikdörtgen ülkesine, paralelkenar grubu eşkenar dörtgen ülkesine
2. kare grubu paralelkenar ülkesine, dikdörtgen grubu eşkenar dörtgen ülkesine
3. kare grubu eşkenar dörtgen ülkesine, dikdörtgen grubu paralelkenar ülkesine gider. Bu kısım 3 etapta tamamlanır)

5. Bunlardan sonra her dörtgen ülkesi grubunun ilk yerine geri döner. Öğretmen "Her grup ülkesine geri döndü. Şimdi her grup kendi içinde bir .... dakikalık televizyon programı hazırlasın. Bu programda gittiğiniz ülkeleri anlatacaksınız. Sizden istenen aldığınız notlar doğrultusunda gittiğiniz ülkeyi eksiksiz ve yanlışsız bir şekilde anlatmanız" der.

6. Her grup diğer ülkeleri anlatan bir .... dakikalık bir TV programı hazırlar. Tüm gruplar hazır olduktan sonra, her gruptan hazırladıkları TV programını sunmaları istenir. Gruplar bu programları sunar iken diğer gruplarında TV programlarını dikkatli izlemeleri, programı hazırlayanların eksiklik ya da yanlışlık yapıp yapmadığını kontrol etmeleri beklenir.

7. Tüm gruplar programlarını sunmayı bitirdikten sonra eğer sunulan TV programlarında bir eksiklik varsa bunu o ülkeye bir mektup yazarak bildirebilecekleri söylenir. Daha sonra bu mektuplar sırayla okunur ve üstünde tartışılır.

8. "Acaba bu ülkelerin ortak yanları var mı?" "Ülkelerin ortak özellikleri neler?" "Bu ülkelerin hepsinin babası sayılabilecek ya da hepsinin özelliklerini taşıyan hangi ülke olabilir?"

Daha önceden bilinmeyen yamuk çeşitleri ve deltoid ile ilgili olarak bu şekillerin uzaydan geldikleri Türkiye Cumhuriyeti Geometri Şekilleri bakanlığının saygıdeğer çalışanları olan sınıftaki öğrencilerin bu şekli incelemeleri ve şekillerle ilgili olarak bir rapor hazırlamaları istenir. Raporlar için ölçütler belirlenebilir; kenar uzunlukları, açılarının ölçüleri, köşegenlerin uzunlukları. Köşegenler arası açılar. Öğrencilere raporlarını yazarken kullanmak üzere aşağıdaki tablo verilir.

ÇALIŞMA YAPRAĞI:	
1.	Şekillerin köşelerine isim verin.
2.	Şekillerin kenarlarına isim verin.
3.	Şekillerin kenar uzunluklarını ölçüp aşağıdaki tabloya yazın.
4.	Şekillerin kenar uzunlukları hakkında ne söylersiniz?
5. 6. 7. 8.	....

Şekil no:	1. kenarının uzunluğu	2. kenarının uzunluğu	3. kenarının uzunluğu	4. kenarının uzunluğu
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9. Şekillerinizin açılarını ölçüp aşağıdaki tabloya yazınız.

10. Şeklinizin açıları hakkında ne söylersiniz?

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Şekil no:	1. açısının ölçüsü	2. açısının ölçüsü	3. açısının ölçüsü	4. açısının ölçüsü
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11. Şekillerin köşegenlerini çizin.

12. Köşegenlerinin uzunluklarını aşağıdaki tabloya yazın.

13. Şekillerin köşegenleri hakkında ne söylersiniz?

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Şekil no:	Köşegenlerinin uzunlukları
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14. Şimdi bu etkinlikte şeklinize ait bulduğunuz özellikleri kısaca özetleyin (Kenarlar, açılar, köşegenler ile ilgili)

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SONUÇ ETKİNLİKLERİ

1. Dörtgenlerin özellikleri tekrar edilir.
2. Konu ile ilgili aşağıdaki sorular öğrencilerle birlikte çözülür.
3. Konu ile ilgili aşağıdaki sorular öğrencilere ödev olarak verilir.

DERS PLANI 9

HEDEF 9: Paralelkenarın, eşkenar dörtgenin, karenin, yamuğun ve deltoidin çevrelerini hesaplayabilme

D1. Kenar uzunlukları verilen bir paralelkenarın çevresini hesaplayıp yazma

D2. Bir kenar uzunluğu verilen bir eşkenar dörtgenin çevresini hesaplayıp yazma

D3. Bir kenar uzunluğu verilen bir karenin çevresini hesaplayıp yazma

D4. Kenar uzunlukları verilen bir yamuğun çevresini hesaplayıp yazma

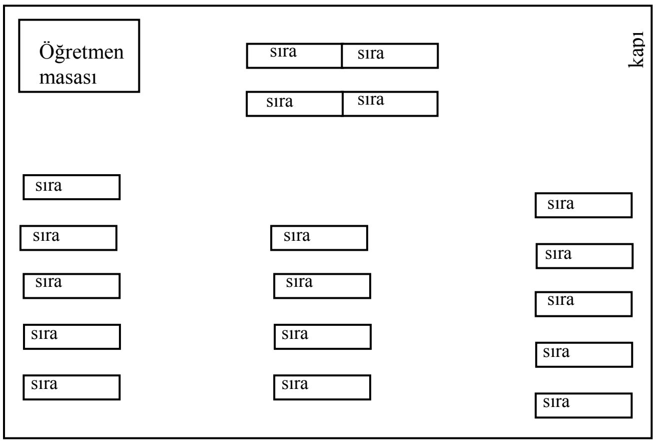
D5. Kenar uzunlukları verilen bir deltoidin çevresini hesaplayıp yazma

Süre: 1 ders saati

Materyal:

Kullanılan drama teknikleri: Uzman rolü, toplantı düzenleme

Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

Müzikle birlikte sınıfta dolaşıyoruz. Müziği durduğumda havaya bir eşkenar dörtgen çizin. Müzik durdurulduğunda yere parmak ucunuzla bir paralelkenar, parmağınızla bir arkadaşınızın sırtına bir deltoid, gözlerinizle havaya bir kare, dirseklerinizle havaya bir dikdörtgen, parmağınızla duvara bir yamuk, göbeğinizle bir paralelkenar, burnunuzla bir deltoid çizin.

GELİŞTİRME ETKİNLİKLERİ

1. Öğrencilere 4erli gruplara ayrılır. Her gruba paralelkenar, dikdörtgen, eşkenar dörtgen, kare, yamuk ve deltoid şeklinde arazi maketleri verilir. Öğretmen "Ben orman bakanlığında çalışan baş mühendisim. Sizler Orman Bakanlığı'nda çalışan mühendislersiniz. Çevresine 1er metre ara ile ağaç dikilecek bir takım arazilerin maketlerini sizlere veriyorlar. Bu arazilerin çevrelerine kaç tane ağaç dikileceğini bulunuz. "der.

2. Öğrenciler cevapları bulduktan sonra, bu hesaplamanın bütün kenarlar ölçmeden nasıl yapılabileceğini grup içinde tartışmaları istenir.

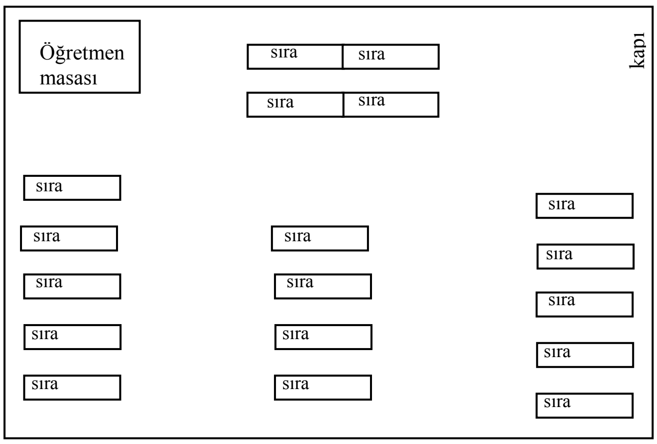
3. Sınıftaki grupların yarısının basın mensubu, yarısının mühendisler olduğu söylenir. Mühendislerden oluşan gruplar, basın mensuplarından oluşan gruplara, yaptıkları çalışma ile ilgili olarak bir açıklama yapacakları söylenir. Mühendisler çevre hesaplamalarının nasıl yapıldığını anlatacaklardır. Basın ise konu ile ilgili olarak

istediği soruyu sorabilecektir. Bu şekilde sınıfta mühendislerin bir basın toplantısı yapması sağlanır.

SONUÇ ETKİNLİKLERİ

1. Konu ile ilgili aşağıdaki sorular çözülür.

DERS PLANI 10
HEDEF 10: Paralelkenarın, üçgenin, eşkenar dörtgenin, yamuğun ve deltoidin alanlarını hesaplayabilme
D1. Bir paralelkenarı kendi alanına eşit alanlı bir dikdörtgene dönüştürerek, meydana gelen dikdörtgenin alanı ile paralelkenarın alanı arasındaki bağıntıyı söyleyip yazma
D2. Bir kenar ile bu kenara ait yüksekliği verilen paralelkenarın alanını hesaplayıp yazma
D3. Bir paralelkenarın bir köşegeni yardımıyla ayrılan üçgenlerden birinin alanı ile paralelkenarın alanı arasındaki bağıntıyı söyleyip yazma
D4. Bir kenarı ve bu kenara ait yüksekliği verilen bir üçgenin alanını hesaplayıp yazma
D5. Dik üçgenin alanını hesaplayıp yazma
D6. Eşkenar dörtgenin ve deltoidin alanı ile köşegenlerinin uzunlukları arasındaki bağıntıyı söyleyip yazma
D7. Köşegenlerinin uzunlukları verilen eşkenar dörtgenin alanını hesaplayıp yazma
D8. Köşegenlerinin uzunlukları verilen deltoidin alanını hesaplayıp yazma
D9. Bir yamuğun alanını, bilinen çokgen alanları yardımıyla hesaplayıp yazma
D10. Tabanları ve yüksekliği verilen bir yamuğun alanını hesaplayıp yazma
D11. Bir dik yamuğun alanını veren bağıntıyı söyleyip yazma
Süre: 1 ders saati
Materyal: Gruplara verilecek üzerinde oyun tahtalarının çizili olduğu kağıtlar, çivili geometri tahtası
Kullanılan drama teknikleri: öğretmenin role girmesi
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ
1. Öğretmen "Hep birlikte bir çember oluşturuyoruz" der. Çemberin iç bölgesinde duracak bir ebe belirlenir. Öğrencilere çemberde duruş sırasına göre kare, dikdörtgen, paralel kenar, deltoid, eşkenar dörtgen, yamuk ismi verilir. Herkesin kendine verilen ismi akılda tutması söylenir.

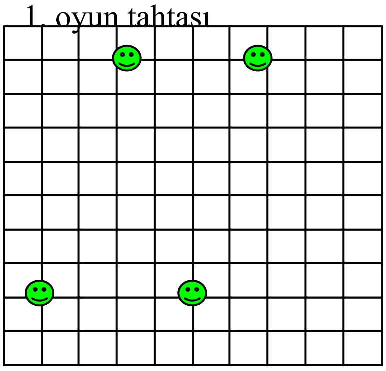
2. Öğretmen "Şimdi ben bir dörtgen ismi söyleyeceğim. Söylediğim dörtgenin ismini vermiş olduğum öğrenciler yerlerinde ayrılacak ve birbirleri ile yer değiştirecek. Bu esnada ebe de bu öğrencilerin yerlerinden ayrılmasından faydalanıp boş kalan bir yere gidebilir. Eğer böyle olursa ebeye yerini kaptıran öğrenci kendisi ebe olur" der. Bir iki denemeyle öğrencilerin oyunu doğru olarak anlaması sağlanır.

GELİŞTİRME ETKİNLİKLERİ

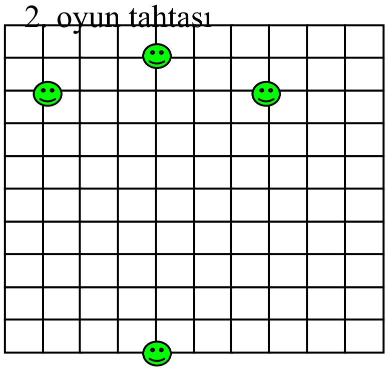
1. Öğretmen sınıfı 4erli gruplara ayırır. Öğrencilere "Şimdi kareli tahta üzerinde oynanan bir oyun oynayacağız. Tahta üzerinde oynanan oyunun kuralı şöyle; tahta üzerinde üstünde gülen yüz olan taşlar var. Oyun tahtası sahibi bu taşlar arasında kalan alan kadar güce sahip demektir. Her gruba 7 tane oyun tahtası resmi olan bir kağıt vereceğim. Grup içinde karar verip bu 7 tahtadan hangisini almak istediğinizi bildireceksiniz. Seçtiğiniz tahtadaki taşlar arasında kalan alan kadar güce sahip olacağınızı unutmayın. En güçlü tahtayı seçen grup oyunu kazanır. Bu oyun için size 25 dakika vereceğim. Bu süre içinde tüm oyun tahtalarının gücünü bulmanızı ve grubunuz için hangi tahtayı istediğinize karar vermenizi istiyorum. Ben süre bitti diyene kadar hiçbir grup kararını açıklamasın" der.

2. Süre sonunda gruplar kararları açıklarlar. Grupların her oyun tahtasının gücünü kaç olarak buldukları sorulur. Her grubun bir geometri tahtalarından birinin gücünü nasıl bulduğunu açıklaması istenir.

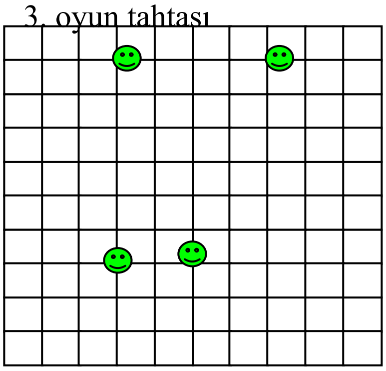
1. oyun tahtası



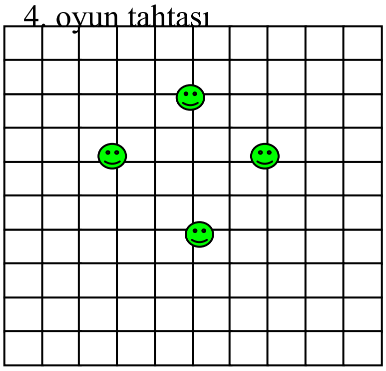
2. oyun tahtası



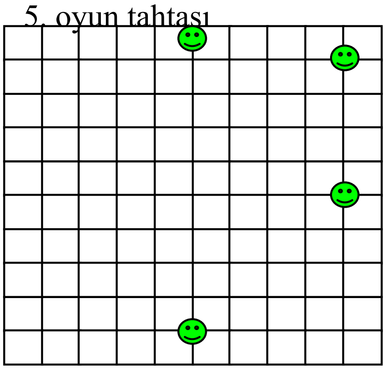
3. oyun tahtası



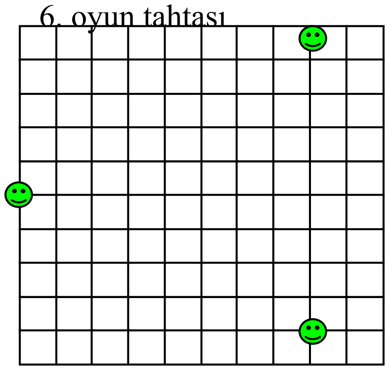
4. oyun tahtası



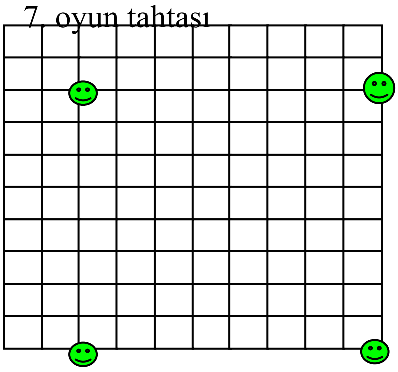
5. oyun tahtası



6. oyun tahtası



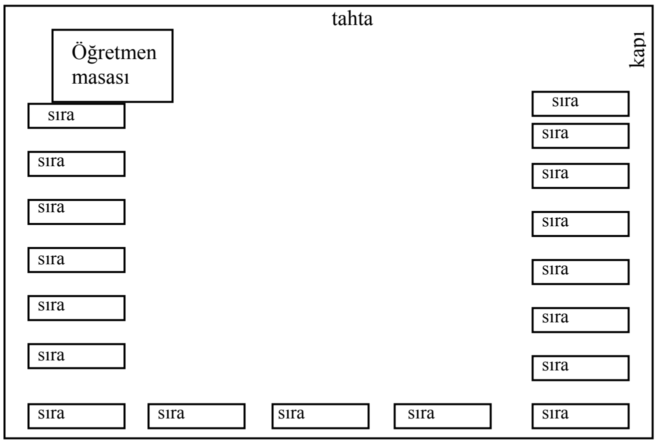
7. oyun tahtası



SONUÇ ETKİNLİKLERİ

1. Öğretmen bu etkinlikte üçgen ve bahsedilen dörtgenlerin alanlarının nasıl bulunduğunu tekrarlar.

DERS PLANI 11
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 1: Çember ve daire ile ilgili kavramlar bilgisi
D1. Düzlemde bir noktadan eşit uzaklıktaki noktaları işaretleyip, bu noktaların oluşturduğu şeklin adını söyleme
D2. Çemberin tanımını söyleme
D3. Verilen çemberin çapını, yarıçapını ve merkezini gösterme
D4. Bir çemberin belirtilmesi için gerekli olan elemanları söyleme
D5. Çemberin düzlemde ayırdığı bölgeleri gösterme
D6. Bir çemberin merkezinin iç ve dış bölgedeki noktalara olan uzaklığı ile yarıçapını karşılaştırıp sonucu yazma
D7. Çember ile iç bölgesinin birleşim kümesini söyleyip yazma
D8. Çember ile daire arasındaki farkı söyleyip yazma
Süre: 1 ders saati
Materyal: Kaset ya da CD çalar, fener, ip, urgan, 4 tane 2 m x 2 m boyutlarında branda, beyaz tahta kalemi,
Kullanılan drama teknikleri: Donuk imge, uzman rolü, öğretmenin role girmesi
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ:

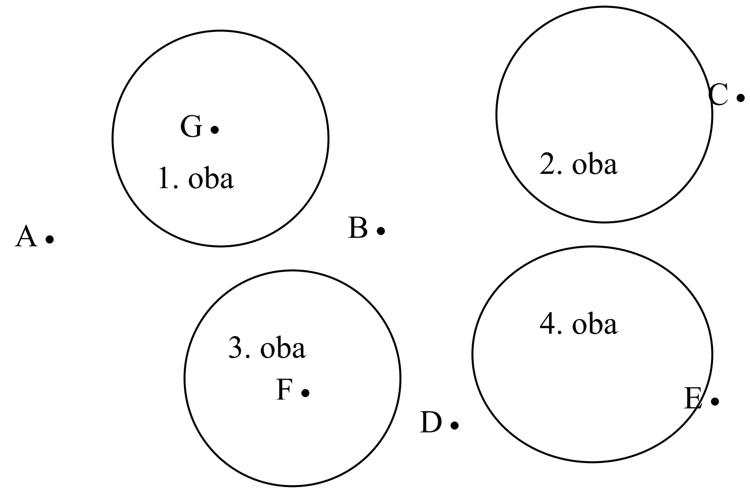
1. Öğrencilere her birinin birer izci olduğu ve hep birlikte izci kampına gidecekleri söylenir. Sınıfta her öğrencinin izci kampına gitmek üzere, sırtında çantası ile tek sıra halinde ve şarkılar söyleyerek yürümesi sağlanır.
2. "Şimdi 4 grup oluyoruz, gruplarda yaklaşık olarak eşit sayıda olmanız koşuluyla istediğiniz gibi gruplar oluşturabilirsiniz. Gruptaki herkes birbirini görecek şekilde dursun. Hep birlikte kampa doğru gelirken ormanda gördüklerimiz üzerinde konuşalım. Yolda gelirken neler gördünüz"
(Öğrencilerin kampa gelirken görmüş olabilecekleri şeyleri saymalarının istenmesi, onların gerçek bir kamp ortamı üzerine düşünmelerini sağlar, gerçekten kampta olduklarını hissetmelerini kolaylaştırır.)
3. Eğer "Yolda gelirken neler gördünüz?" sorusuna cevap alınmazsa, "Ormanda neler görebilirsiniz?", "Doğada geçen filmlerde neler vardır?" gibi ek sorular sorulur.

Öğrencilerden kuş, mantar, ağaç, çiçek, taş vb. cevaplar beklenir. Bu cevaplar üzerine grupların bu 5 şeyi fotoğraf anı olarak canlandırmaları istenir.

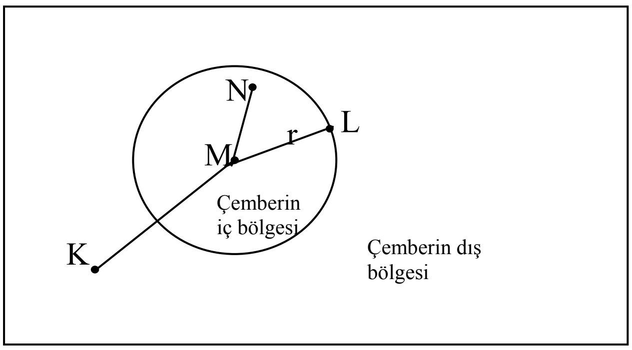
GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen artık kamp yapılacak araziye gelindiğini, arazide kamp yerini düzenlemek gerektiğini ve bunun için izcilerin obalar halinde çalışacaklarını bildirir. Giriş etkinliğinde oluşturulan gruplar gibi öğrencilerin 7-8 kişilik gruplar oluşturmalarını söyler. Öğretmen, "Bu gruplardan her birine oba diyeceğiz. Şimdi her oba şu kapalı kağıtlarda yazılı olan, içecek su getirme, yakacak odun toplama, çadır kurma, eşyaları yerleştirme işlerinden bir tanesini çekecek ve bu işi 2 dk. içinde bitirecek. Bu arada her gruba izciliğe ait teknik iz işaretleri vereceğim. Buradaki işaretleri sınıfın bir yerlerinde görebilirsiniz. Eğer bir işaret görürseniz, tüm grup bu işareti oluşturun" der ve öğrencilere 2 dakika süre verir.
(Böylece ileriki aşamalarda birlikte çalışacak oba elemanlarının kaynaşması sağlanmış olur).
2. Bütün obalar işlerini bitirdikten sonra, her oba için belli bir alan verilir. "Şimdi size gerekli materyalleri vereceğim ve bu alanlarda ateşlerinizi yakacaksınız" denir ve öğrencilerin kendilerine verilen feneri kullanarak sembolik olarak ateş yakması beklenir.
3. Öğretmen, "Artık hava soğumaya başladı. Her oba ısınmak için kendi ateşini kullanacak. Şimdi her oba ateşin çevresinde dursun. Yalnız obadaki herkesin ateşin ısısından eşit olarak faydalanmasını istiyorum. Obadaki herkesin nasıl ateşten eşit olarak yararlanabileceğini düşünün. Daha sonra obada herkesin, obanın ateşinden eşit olarak yararlanabildiği durumu bir fotoğrafa dönüştürmenizi istiyorum. Fotoğrafı oluşturduktan sonra bir süre donup bekleyin." der. Burada öğrencilerden herkesin eşit şekilde ısınabilmesi için, çember şeklinde durmaları gerektiğini bulmaları beklenir.
4. Öğrenciler ateş çevresinde çember oluşturacak şekilde durduktan sonra, üzerinde durdukları çemberler tebeşirle yere çizilir. Öğretmen "Bundan böyle bu çembere, 'ateş çemberi' ismini vereceğiz. Şimdi obada herkes ateşe eşit uzaklıkta oldu mu?", "Nereden biliyoruz?", "Bunu nasıl gösterebilirsiniz?" der. Burada öğrencilerin sınıf ortamında bulunan ipler yardımı ile aşağıdakileri yapması beklenir;
   a. Her bir izcinin ateşe olan uzaklığını iple belirlenmesi, yani her bir öğrencinin bulunduğu yer ile ateş arasındaki uzaklığın ne kadar ip uzunluğunda olduğunu belirlenmesi
   b. Öğrencilerin, herkesin ateşe eşit uzaklıkta olduğunu, yani kendileri ile ateş arasında gerilen iplerin her birinin uzunluğunun eşit olduğunu belirlemeleri
5. ARA ÖZET: Ölçüm bittikten sonra, yani çember şeklinde oturulduğunda her izcinin ateşten eşit olarak yararlanacağı belirlendikten sonra, tahtaya, etkinliğin buraya kadar olan kısmını anlatmak üzere çember çizilir. Çember üzerinde her bireyin ortadaki ateşe eşit uzaklıkta olduğu üzerinde konuşulur. Öğretmen düzlemde bir noktadan eşit uzaklıkta bulunan noktalar kümesine, 'çember' adı verildiğini, bu etkinlikte ateşin 'çemberin merkezi' olduğu ve her bir izcinin ateşe uzaklığının 'yarıçap uzunluğu' olarak adlandırıldığını anlatır. M merkezli ve r yarıçaplı bir çemberin Ç (M, r) ile gösterildiğini söyler ve tahtaya yazar. Tahtadaki çizimleri öğrencinin defterine yazması beklenir.

6. Öğretmen, "Artık, obalar ateşlerinin başındalar. Her öğrenci ateşe eşit uzaklıkta duruyor ve herkes ısınabiliyor. Peki ısınmak için ben nerede durmalıyım?" der. Daha sonra obaların ateş çemberlerinin dışında ve içinde yer alan yukarıdaki şekilde A, B, C, D, E, F ve G ile gösterilen çeşitli yerlere gider ve her seferinde "Burada dursam ısınabilir miyim? Niçin?" diye sorar. Bu şekilde çemberlerin iç ve dış bölgelerinde verilen bu çeşitli noktalar üzerinde konuşularak, öğrencilerde 'çemberin iç ve dış bölgeleri' kavramları oluşturulması sağlanır.



7. ARA ÖZET: Öğretmen tahtaya aşağıdaki şekli çizer ve şekille ilgili açıklamaları söyleyerek yazar;



a. Eğer bir noktanın çemberin merkezine uzaklığı çemberin yarıçapından büyük ise nokta çemberin dış bölgesindedir. Sembollerle gösterirsek, $|KM| > r$ ise, K noktası çemberin dış bölgesindedir. Dış bölge; $\{K \mid |KM| > r\}$ dir.

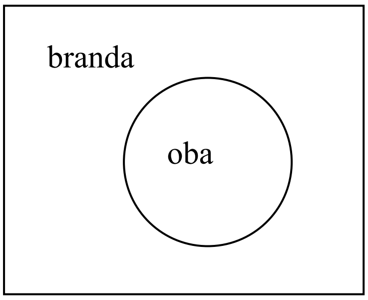
b. Eğer bir noktanın çemberin merkezine uzaklığı çemberin yarıçapından küçük ise nokta çemberin iç bölgesindedir. Sembollerle gösterirsek, $|NM| < r$ ise, N noktası çemberin iç bölgesindedir. İç bölge; $\{N \mid |NM| < r\}$ dir.

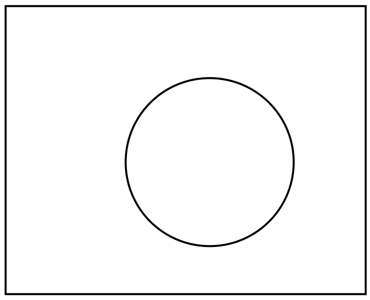
c. Eğer bir noktanın çemberin merkezine uzaklığı çemberin yarıçapına eşit ise nokta çemberin üzerindedir. Sembollerle gösterirsek; |LM| = r ise, L noktası çemberin üstündedir. Çember; {L | |LM| = r} dir."

8. Obalar hala ateş çemberi üzerinde durmaktadırlar. Öğretmen, "Birden yağmur yağmaya başladı. Yağmurun bizde ne gibi etkileri olabilir?" der. Öğrencilerin, ateşin sönebileceğini ve ıslanabileceklerini bulmaları beklenmektedir.

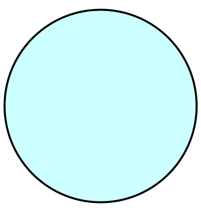
9. Öğretmen, "Ateşlerimizi yaktığımızdan beri, obadaki herkesin eşit olarak ısınabilmesi için ateşe eşit uzaklıkta durmasını istiyoruz. Şimdi yağmur yağmaya başladı ve artık ateşin sönmemesini ve hiç kimsenin ıslanmamasını da sağlamamız lazım. Obada herkesin ateş çemberi üzerinde dururken yağmurdan ıslanmamasını ve ateşin sönmemesini sağlamak için ne yapalım?" der. Cevap alınamazsa, "Yağmurda dışarı çıkmak zorundaysanız, nasıl bir önlemle dışarı çıkarsınız? Yağmur için tedbir almadığınız bir gün dışarıda dolaşırken birden yağmur yağmaya başlasa ne yaparsınız?" vb. sorularla şemsiye, yağmurluk, altına sığınılacak bir örtü düşüncesi çağrıştırılmaya çalışılır. Öğrencilerde sınıf ortamında daha önceden bulunan büyük branda/naylondan faydalanabilecekleri düşüncesinin oluşması beklenir.

10. Sınıfa getirilmiş olan branda ateşi ve her bir obayı yağmurdan koruyacak büyüklükte ve dikdörtgen şeklindedir. Öğretmen "Hem ıslanmaktan korunmak ve ateşin sönmesini engellemek, hem de ateşten eşit uzaklıkta olabilmek için bu brandayı nasıl tutmamız gerekir? Brandayı uçlarından tutarsak ne olur? Ateş çemberi üzerindeyken brandayı uçlarından tutabilir misiniz?" der. Burada öğrencilerin brandanın dikdörtgen şeklini bozmaları gerektiğini hissetmeleri sağlanır.





11. En kolay tutma yönteminin brandayı izcilerin yerleştikleri çember büyüklüğünde kesmeleri olduğu fikrinin bulunması sağlandıktan sonra, brandalar kesilir. Aşağıdaki gibi şekiller (daireler) oluşur. Öğretmen "Şimdi brandanızı nasıl tutmanız gerektiğini gösterin" der.



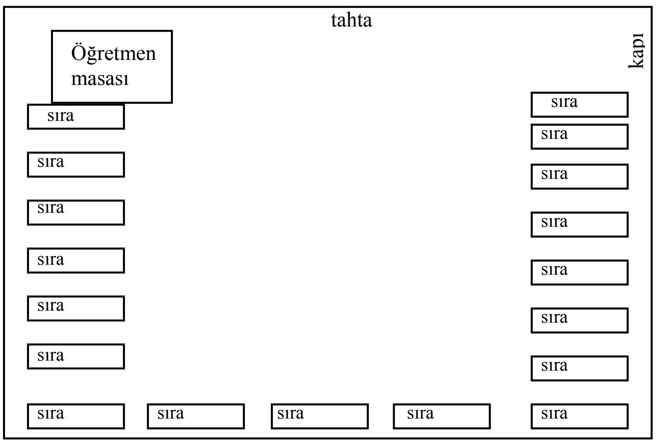
12. Öğretmen "Oluşan bu şekil de bir çember mi? Çemberden bir farkı var mı? Varsa nedir ya da nelerdir?" diye sorar. Daha sonra bu şeklin daire olduğu söyler. "Çember ve iç bölgesinin birleşimine 'daire' denildiğini ve M merkezli r yarıçaplı bir dairenin D (M, r) ile gösterileceğini söyler ve tahtaya yazar.
13. Öğretmen "Şimdi bütün gruplar ateş çemberlerini unutsunlar, sizden hep birlikte hızla bir çember oluşturmanızı istiyorum. Şimdi ağır çekimde bir daire oluşturmanızı istiyorum" der. Daire oluşturulduktan sonra şimdi hızlı hızlı 3 tane çember oluşturun. Bir büyük, bir küçük çember oluşturun. Şimdi ağır çekim 2 tane daire oluşturun" der. Oluşan çemberler ve daireler üzerinde konuşulur.

SONUÇ ETKİNLİKLERİ

14. Her obanın çember şeklinde olan 5 tane nesne adı bulmaları için 2 dakika süre verilir (hulahop, simit, susamlı bisküvi, bilezik, conta, vb.). Obalara çember şeklinde susamlı bisküvi dağıtılır ve izcilerin incelemesi istenir. Öğrencilerden çember tanımı sorulur.
15. Öğrencilerden hep birlikte büyük bir çember oluşturmaları istenir. Çemberin içine ve dışına sınıfta bulunan bir takım nesneler (defter, çanta, tahta silgisi, kalem, vb.) konur. Hangi nesnelerin çemberin içinde, hangilerinin dışında olduğu sorulur. Buradan çemberin iç ve dış bölgeleri kavramları yeniden vurgulanır.

16. Obalardan 2 dakika içinde 5 tane daire örneği bulmaları istenir (bisküvi, şişe kapağı, tencere kapağı, frizbi, tepsi, metal para, saat, vs). Öğrenciler daire şeklinde bisküviler dağıtılır, bu bisküvilerin çember susamlı bisküvilerle aralarındaki fark sorulur.

DERS PLANI 12
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 2: Bir doğrunun çembere göre durumlarını kavrayabilme
D1. Bir doğrunun, verilen bir çembere göre durumlarını söyleyip yazma
D2. Bir çemberde, teğet ile değme noktasını merkeze birleştiren doğrunun birbirine göre durumunu söyleyip yazma
D3. Bir çemberin merkezine olan uzaklığı verilen bir doğrunun, o çembere göre durumunu söyleyip yazma
D4. Çemberde, bir kirişin orta noktası ile merkezden geçen doğrunun kirişe göre durumunu söyleyip yazma
D5. Bir çemberde, birbirine eşit kirişlerin merkeze olan uzaklıklarını karşılaştırarak sonucu söyleyip yazma
D6. Bir çemberde, biri diğerinden büyük kirişlerin merkeze olan uzaklıklarını karşılaştırarak sonucu söyleyip yazma
D7. Bir çemberde, en büyük kirişin çap olduğunu söyleyip yazma
D8. Merkezi belli olmayan çizilmiş bir çemberin merkezini ve yarıçapının ölçüsünü çizim yardımıyla bulma
D9. Bir çemberde, birbirine eşit kirişlere ait yayların ölçülerini karşılaştırarak sonucu söyleyip yazma
D10. Bir çemberde, biri diğerinden büyük olan kirişlere ait yayların ölçülerini karşılaştırarak sonucu söyleyip yazma
Süre: 2 ders saati
Materyal:
Kullanılan drama teknikleri: Donuk imge, rol içinde yazma, öğretmenin role girmesi
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ:

1. Öğretmen, "Şimdi sizden çemberler çizmenizi istiyorum. Serçe parmağınızı, omuzlarınızı, ayak bileklerinizi, dirsekleriniz, dizinizi, avuç içinizi, başınızı, gözünüzü, burnunuzu kullanarak çemberler çizin. Size ellerimi çırparak ritim vereceğim, çemberleri bu ritme uyarak çizin." der.

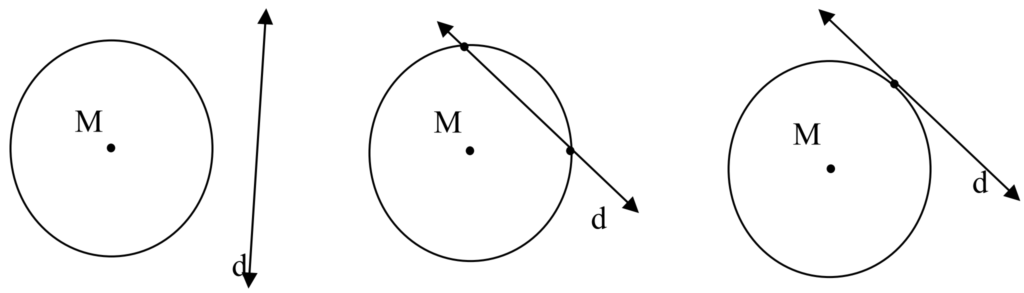
2.Öğretmen öğrencilerden teknik iz işaretlerinden 'Hazır, Dikkat' işaretini oluşturmalarını ister.

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen, "Ormanda kurmuş ağaçlar görevliler tarafından işaretlenir ve bir süre sonra başka görevliler işaretli ağaçları kesmeye gelirler. Eğer işaretli bir kuru ağaç izcilerin ateş çemberi etrafında ise kesildiğinde ateş çemberi üzerine düşebilir değil mi? O zaman ateş çemberinde oturan izcilere ne olur?"(öğrencilerden bu durumda ateş çemberinde oturan izcilerden birinin ya da birkaçın yaralanabileceğini bulmaları beklenir).

Öğretmen "ben Orman Bakanlığında "izcileri kazalardan koruma" projesine başkan olarak tayin edildim. Bu yıl bakanlığımıza kuru ağaç kesimlerinde yaralanan 18 izci şikayet dilekçesi verdi. İzcilerin kuru ağaç kesimlerinde yaralanmalarını önlemek amacıyla bir proje geliştirmemiz gerekiyor. İlk olarak siz mühendislerin ateş çevresinde kesilen ağaçların hangi değişik durumlarda düşebileceğini tespit etmemizi istiyorum. Şimdi 4erli gruplar oluşturmanızı istiyorum. Her grup ateş çemberi yakınında bulunan bir kuru ağacın kesildiğinde ne gibi durumlarda yere düşebileceğini düşünsün ve farklı durumları defterlerine çizsin" der.

2. Her grup değişik durumları tespit edip defterine çizdikten sonra grupların bu durumları donuk imge ile canlandırmaları istenir. (Öğrencilerden aşağıdaki durumları donuk imge olarak oluşturmaları beklenir)



1. durum 2. durum 3. durum

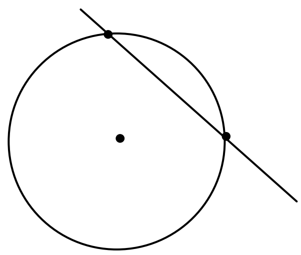
3. Tüm obalar duruşlarını tamamladıktan sonra, obaların, duruşlarını anlatmaları istenir. Bir oba çizimleri anlatırken sözü kesilip diğer bir obanın devam etmesi istenerek tüm obaların bu süreçte söz hakkı alması ve diğer obaları dinlemesi sağlanır.

4. Her bir obaya 'Durum 3' ün çizili olduğu bir kağıt verilir. Öğretmen, "Eğer yere düşen ağaç yandaki gibi düşmüş olsaydı, burada ağacın ateş çemberine yani doğrunun çembere teğet olduğunu söyleyecektik" der. Doğrunun çembere teğet olduğu bu durumu inceleyiniz." der. Öğretmen burada obabaşı olarak role girerek

- Değme noktası ile merkezi birleştir.
- Değme noktası ile merkez arası uzaklığı ölç.
- Değme noktası ile merkez arasındaki doğru parçası ile teğet arasındaki açıyı ölç.

şeklindeki ipuçlarını vererek öğrencilerin teğetin özelliklerini bulmalarını sağlar.

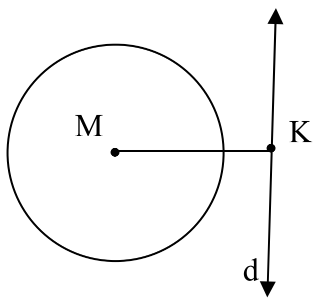
5. Her bir obaya 'Durum 2' nin çizili olduğu bir kağıt verilir. Öğretmen, "Eğer yere düşen ağaç yandaki gibi düşmüş olsaydı, burada doğrunun çemberi kestiği iki nokta arasında kalan doğru parçasına kiriş adı verecektik" der. Öğrencilerin bu durumu incelemelerini ister. Burada da obabaşı olarak role girip aşağıdaki ipuçlarını verir;



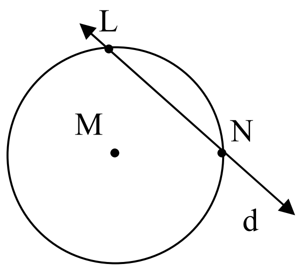
- Kirişin orta noktasını bul ve bir isim ver. Kirişin orta noktası ile merkezi birleştir.
- Kirişin orta noktası ile merkez arası uzaklığı ölç.
- Kirişin orta noktası ile noktası ile merkez arasındaki doğru parçası ve kiriş arasında kalan açıyı ölç.

6. Daha sonra öğretmen, öğrencilerin 3. ve 4. maddelerde bulmuş oldukları sonuçlar doğrultusunda, teğet ve kirişin özelliklerini tekrarlayarak tahtaya yazar;

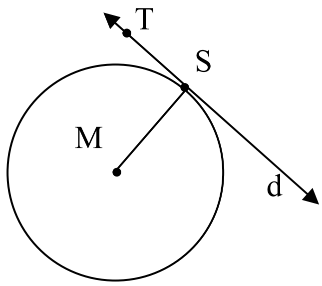
1. Durum: d doğrusu ile Ç (M, r) çemberinin hiç ortak noktaları yoktur. Yani kesişmezler. d doğrusu üzerindeki herhangi bir K noktası alırsak |MK| > r ve d ∩ Ç = { } dir.



2. Durum: d doğrusu ile Ç (M, r) çemberinin iki ortak noktaları vardır. Yani doğru çemberi iki noktada keser. d doğrusu üzerindeki herhangi bir K noktası alırsak |MK| < r ve d ∩ Ç = {L, N } dir. Çemberi iki noktada kesen doğrulara, 'kesen' denir. Bir çemberin iki noktasını birleştiren doğru parçalarına bu 'çemberin kirişi' denir.

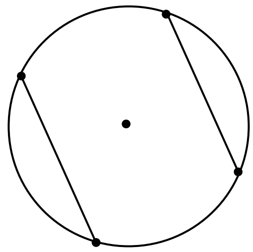


3. Durum: d doğrusu ile Ç (M, r) çemberinin bir ortak noktası vardır. Yani doğru çemberi bir noktada keser. Şekildeki |MS| = r ve d ∩ Ç = {S } dir. Çemberle bir ortak noktası olan doğrulara, 'çemberin teğeti' denir. Ortak noktaya 'teğetin değme noktası' denir. Aşağıdaki şekilde teğetin değme *noktası S'dir. Teğetin değme noktası olan S ile merkezi birleştiren doğru parçası, teğete diktir. [MS] ⊥ d dir. Şekilde s(MST) = 90°. Kısaca, bir çembere teğet alınan doğru, değme noktasında yarıçapa diktir.*



7. Obalara, çemberde aynı uzunlukta iki tane kiriş olan yandaki durum verilir. Öğretmen, "Buradaki devrilen **eşit** uzunluktaki kütüklerin ateşe uzaklıkları hakkında ne söylersiniz? " der. Öğretmen yine obabaşı rolünde aşağıdaki ipuçlarını verir;

İpuçları:

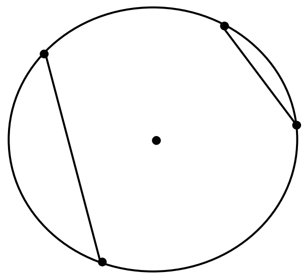


- Kirişleri isimlendirin.
- Kirişlerin uzunluklarını ölçüp karşılaştırın.
- Kirişlerin merkeze uzaklıklarını ölçüp karşılaştırın.
- Kirişlerin uzunlukları ve merkeze uzaklıkları hakkında ne söylersiniz.
- Cevabınızı diğer obaların buldukları sonuçlarla karşılaştırın; onlar da aynı şeyi bulmuşlar mı?

Bu ipuçlarının sonunda öğrencilerin "aynı uzunluktaki kirişlerin, çemberin merkezine uzaklıklarının eşit olduğunu bulmaları" beklenir.

8. Obalara iki farklı uzunlukta kiriş içeren yandaki resim verilir. Burada da ateşin çevresine düşmüş iki tane kütük vardır fakat kütüklerin uzunlukları birbirinden farklıdır. Bu farklı uzunluktaki kirişlerin ateşe uzaklıklarının incelenmesi istenir. Obabaşı rolündeki öğretmen aşağıdaki ipuçlarını verir;

İpuçları:



- Kirişleri isimlendirin.
- Kirişlerin uzunluklarını ölçüp karşılaştırın.
- Kirişlerin merkeze uzaklıklarını ölçüp karşılaştırın.
- Kirişlerin uzunlukları ve merkeze uzaklıkları hakkında ne söylersiniz.
- Cevabınızı diğer obaların buldukları sonuçlarla karşılaştırın; onlar da aynı şeyi bulmuşlar mı?

Burada öğrencilerin farklı uzunluktaki kirişlerden uzun olanının çemberin merkezine daha yakın olduğunu bulmaları beklenir.

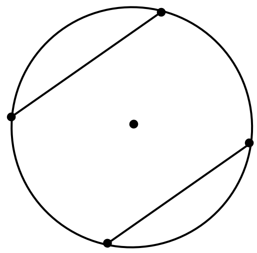
9. Öğretmen, "Ateşin çevresine iki tane kütük düştüğündeki duruma geri dönelim. Ateşin çevresindeki kütüklerle uğraşırken ateşimiz söndü. Daha da kötüsü ateşin yerini kaybettik. Ateşi eski yerine nasıl yerleştirebilirsiniz? " der. Bu kez

kampın yakınında bulunan yüz yaşındaki bir ağaç rolüne girerek, "Kirişlerin orta noktalarının yarıçapa dik olduğu bilgisini hatırlayın" ipucunu verir.
Burada öğrencilerin, aynı çembere ait farklı kirişlerin orta noktalarından çıkılan dikmelerin kesim noktalarının, merkez olduğunu bulmaları beklenir.

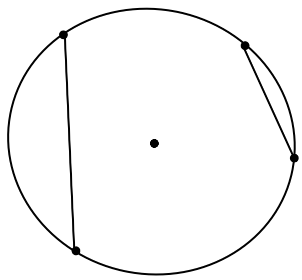
10. Öğretmen, "Ateş çemberinde karşı tarafa çember üzerinde yürümeden geçmek istiyorsunuz. Bu geçişte hangi yoldan giderseniz buradaki en uzun yoldan geçmiş olursunuz? " der. Öğrencilerden istenen, ateşin çevresindeki çemberden yararlanarak buradaki en büyük kirişi bulmalarıdır.
Öğrencilerin en büyük kirişin çap olduğunu bulmaları beklenmektedir.

11. Öğretmen, "Kütüğün bir ucundan diğer ucuna çember üzerinden yürüdüğümüzde bir yay çizeriz. Geçtiğimiz yola 'YAY' adı verilir. Birbirine eşit boydaki kütüklerin başlangıcına ve sonuna işaret koyalım. Şimdide obadan biri bu yaydan yürüsün. Diğer yay için de aynı işlemi tekrarlayalım. Bu iki durumda alınan yol için ne söylersiniz?" diyerek aynı kirişe ait yayların uzunluklarını karşılaştırmalarını ister.

Burada öğrencilerin eş uzunluktaki kirişlere ait yayların uzunluklarının da eşit olduğunu bulması beklenir.



12. Öğretmen, bu kez, "Çembere düşen birbirinden farklı boydaki kütüklerin oluşturdukları yaylar üzerinde yürüyerek alınan yollar hakkında ne söylersiniz? " diyerek, çembere düşen boyları birbirinden farklı olan yayları karşılaştırmalarını ister.



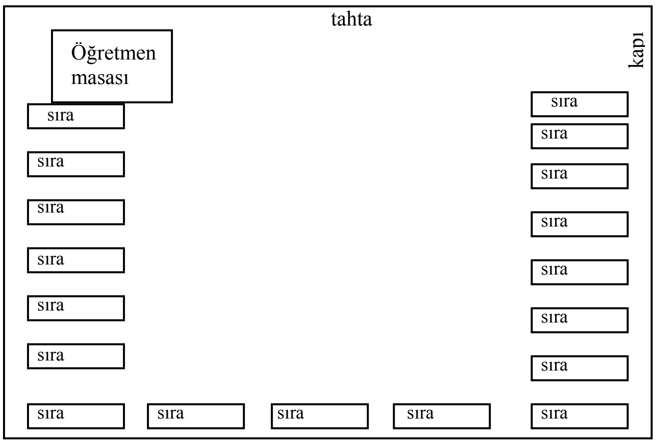
Burada öğrencilerin, uzunlukları birbirinden farklı olan kirişlerden, uzun olanına ait olan yayın daha uzun olduğunu bulmaları beklenir.

13. Öğrencilerden, kampın nöbetçisi olarak bu kamp alanına düşebilecek kütüklerin durumlarının neler olabileceğini anlatan ve çizimler içeren bir rapor yazmaları istenir.

SONUÇ ETKİNLİKLERİ

1. Öğrencilerin yazdıkları raporlar sınıfta sunulur.
2. Öğretmen teğetin ve değme noktasının özellikleri tekrar vurgular.
3. Öğretmen öğrencilerden bir doğrunun bir çemberi iki noktada kestiği durumu canlandırmalarını ister. Oluşan kesenin ve kirişin özellikleri tekrar vurgulanır.
4. Öğretmen çemberde bulunan aynı ve farklı uzunluktaki kirişlerin özelliklerini ve bunların oluşturdukları yaylarla ilişkilerini özetler.

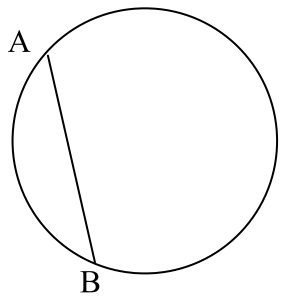
DERS PLANI 13
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 3: Çemberde yay ve açıları kavrayabilme
D1. Bir çember üzerinde belirtilen noktaların oluşturduğu yayları gösterip sembol kullanarak yazma
D2. Bir çemberde merkez açıyı gösterip sembol kullanarak yazma
D3. Çemberde, bir merkez açı ile bu açını gördüğü yay arasındaki ilişkiyi söyleyip sembol kullanarak yazma
D4. Çemberde, birbirine eş yayları gören merkez açılar arasındaki ilişkiyi söyleyip yazma
D5. Çemberde, biri diğerinden büyük yayları gören merkez açılar arasındaki ilişkiyi söyleyip yazma
D6. Çemberde, bir çevre açıyı gösterip sembol kullanarak yazma
D7. Çemberde, bir çevre açı ile bu açının gördüğü yay arasındaki ilişkiyi söyleyip yazma
D8 Çemberde, aynı veya eş yayları gören çevre açıların ölçüleri arasındaki ilişkiyi söyleyip yazma
D9. Çemberde, çapı gören çevre açının ölçüsünü söyleyip yazma
D10. Çemberde, aynı yayı gören merkez açıyla çevre açı arasındaki ilişkiyi söyleyip yazma
Süre:3 ders saati
Materyal: Işıldak
Kullanılan drama teknikleri: Donuk imge, toplantı düzenleme, öğretmenin rol alması
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ:

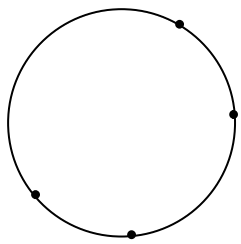
Öğretmenin, "Sınıfta müzik eşliğinde dolaşıyoruz. Şimdi bir çember oluşturduk. Çember üzerinde yürüyoruz. Yürüyüşünüzü yavaşlatın, yavaş yavaş yürüyoruz. Şimdi yürüyüşümüzü hızlandırdık. Yağmurlu bir günde eve ulaşmaya çalışıyormuş gibi yürüyorsunuz. Arkanızdan bir katil takip ediyormuş gibi yürüyün. Durun, şimdi geriye dönüp çember üzerinde diğer tarafa doğru yürüyoruz. Vakit geçirmeye çalışıyormuş gibi yürüyün. Vitrinlere bakıyorsunuz. Elimi çırptığımda 7 kişiden oluşan çemberler oluşturun" yönergeleri ile öğrencilerin sonraki etkinlikler için hazır olmaları sağlanır.

GELİŞTİRME ETKİNLİKLERİ

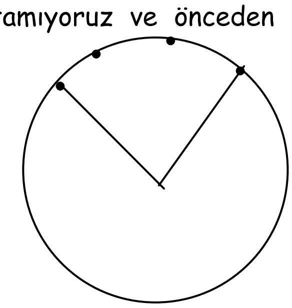


1. Öğretmen, "A ve B noktaları arasına düşen kütüğü AB yayı olarak gösteriyoruz." diyerek tahtaya yazar. "Şimdi önceki etkinlikte oluşturduğunuz gruplarınız içerisinde bir çember oluşturun. Bu çember üzerinde bir yay gösterin. Bu çemberde başka bir yay gösterin." der.

2. Öğretmen, role girerek, "Arkadaşlar yine kamptayız. Fakat bu kez kamptaki izciler değil, bir kampta buluşan eğitimci liderlersiniz, ben de kamptaki baş liderim. Aranızdan, benden sonra baş lider olacak arkadaşımı seçmek istiyorum. Yine gruplar halinde çalışacaksınız ve size yönelttiğim sorulara yanıt vereceksiniz." der.



3. Öğretmen, "Obadan bazı izciler başka bir kampa gittiler. Ateş çemberinde duran az sayıda eğitimci lider kaldı. Ateşi yerinden oynatamıyoruz ve önceden çizdiğimiz ateşe eşit uzaklıkta belirlenen çember şeklindeki durma yerlerini de değiştiremiyoruz. Bu az sayıdaki kişinin yine ateşten eşit şekilde yararlanmasını ve yine çember üzerinde durmasını istiyoruz. Fakat boş kalan yerlere boşuna ateşin ısısının gitmemesi gerek. Bu durumda ateşe ne yapalım ve/veya sizlerin nasıl durması gerekiyor?" der. Gruplar kendi içlerinde tartışırlar.

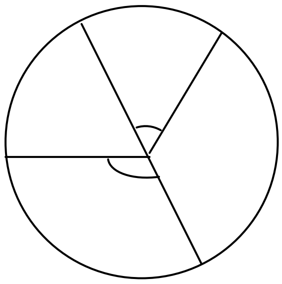


Burada öğrencilerin ateş çemberinde merkez açılar oluşturarak ateşin sadece bu açı içinde kalmasını sağlamaları beklenir.

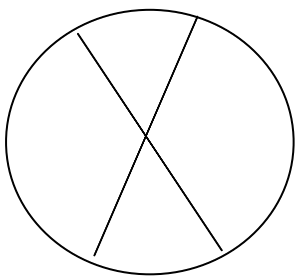
4. Öğretmen tahtaya, köşesi çemberin merkezinde olan açıya, 'merkez açı' denildiğini yazar. Merkez açının kenarları arasında kalan yaya 'merkez açının gördüğü yay' denir.

5. Öğretmen, "Ateş eskiden kaç derecelik alanı ısıtıyordu? Buradaki açının büyüklüğü ne? Şimdi ne kadar alanı ısıtıyor? Buradaki yayın büyüklüğü ne olabilir?" diye sorar, grupların düşünüp, gerekli ölçümü yapıp, cevabı bulmaları için süre verir.
Öğrencilerden, ateş eskiden 360° ısıtırken şimdi daha küçük bir açı ısıttığını söylemeleri beklenir. Öğretmen tahtaya merkez açının ölçüsünün gördüğü yayın ölçüsüne eşit olduğunu yazar.

6. Öğretmen, "Ateşin çevresinde, sayıları azalan izciler, yan yana değil de, iki ayrı yerde dursalar nasıl bir durumda olurlardı? Bu durumu her grup bir fotoğraf anı ile göstersin." der.
Öğrencilerin yandaki şekilde olduğu gibi aynı çember üzerinde iki tane merkez açı oluşturmaları beklenir.

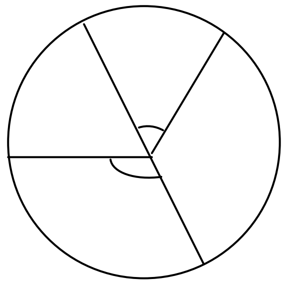


7. Öğrencilere, oluşturdukları fotoğraf anlarında durdukları yayın uzunluğu eşit olduğunda, bu izcilerin ateşten yararlanma açılarının (merkez açılar) belli bir özelliğe sahip olacağını söyler. Eğitimci liderler olarak, bu açılara ilişkin özellikleri bulmalarını istediğini söyler.
Burada öğrencilerin eşit uzunlukta yayları gören merkez açıların ölçülerinin eşit olduğunu bulmaları beklenir. Ardından öğretmen tahtaya eşit uzunluktaki yayları gören merkez açıların ölçülerinin eşit olduğunu yazar.



8. Öğretmen öğrencilere tüm sınıfın hep birlikte bir çember üzerinde farklı uzunluktaki yayları gören merkez açılar canlandırmalarını söyler. Burada farklı uzunluktaki yayları gören merkez açıların ölçüleri arasındaki ilişkiyi bulmalarını ister.

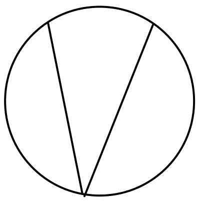
Burada büyük yayı gören merkez açısının ölçüsünün daha büyük olduğunun bulunması beklenmektedir.



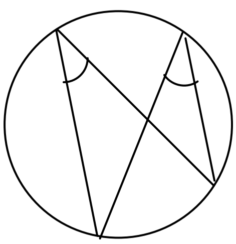
9. Öğretmen, "Hava karardı ve ateşimiz söndü. Birbirinizi görmekte zorlanıyorsunuz. Aydınlanmak için elimizde ışıldak var. Ateş çemberinde, yine çemberi doldurmayacak kadar kişisiniz, ÇEMBER ÜZERİNDE DURAN BİR KİŞİ, ışıldak yardımıyla sizleri nasıl aydınlatabilir?" diye sorar. Öğrencilerin cevabı bulmaları için süre verilir. Burada öğrencilerin çevre açıyı düşünebilmeleri beklenir.

10. Öğretmen tahtaya köşesi çember üzerinde olan ve kenarları çemberi kesen açılara, 'çevre açı' denildiğini, çevre açının kenarları arasında kalan yaya 'çevre açının gördüğü yay' adı verildiğini yazar.

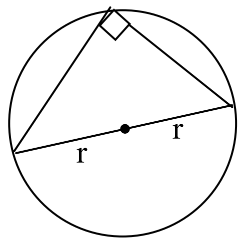
11. Öğretmen, "Yandaki gibi, ateş çemberi üzerindeki bir izcinin ışıldak ile çemberde aydınlattığı ve üzerinde izcilerin bulunduğu bölgenin (yayın) uzunluğu nedir? Yayın uzunluğu ile aydınlanma açısı arasındaki ilişki nedir?" der, öğrencilere düşünmeleri için süre verir. Süre sonunda gruplara cevaplarını sorar. Cevaplar sınıfta tartışılır.
Ardından öğretmen çevre açının ölçüsünün gördüğü yayın ölçüsüne eşit olduğunu söyler ve tahtaya yazar.



12. Öğretmen, "Yandaki şekilde olduğu gibi iki tane ışıldak olsa ve çember üzerinde, yine izcilerin bulunduğu, aynı bölgeyi (aynı yayı) aydınlatsalar, aydınlatma açıları hakkında ne söylersiniz?" diye sorar. Öğrencilere düşünme ve grup içinde tartışma süresi verilir. Süre sonunda gruplardan cevaplar alınıp sınıfça tartışılır. Burada aynı yayı gören çevre açıların ölçülerinin eşit olduğunun bulunması beklenir.

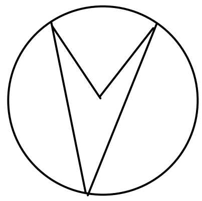


13. Öğretmen, "Yandaki şekildeki gibi bir kişi ışık tuttu ve görünen kısım aydınlandı. Aydınlanan bölgenin köşeleri birleştirildiğinde fark ettik ki bu çapa eşit. Aydınlanma açısını inceleyin, ölçün." der. Ölçüm yapılması ve grup içinde bu durumun tartışılması için süre verir. Burada öğrencilerin çapı gören çevre açının 90° olduğunu bulmaları beklenir. Daha sonra öğretmen tahtaya bu bilgiyi yazar.



14. Öğretmen, "Sınıfta hep birlikte aynı yayı gören çevre ve merkez açıyı bir fotoğraf anı ile canlandırın ve bir süre donarak, bu fotoğraf anını gösterin" der. Öğrenciler, istenen fotoğraf anını gösterdikten sonra, buradaki aynı yayı aydınlatan ateş açısı (merkez açı) ile bu açı arasındaki ilişkiyi bulmalarını ister. Baş lider rolünde aşağıdaki ipuçlarını verir.
İpuçları:

- Işıldak açısının ölçüsünü bulun.
- Ateş açısının ölçüsünü bulun.
- Bu açıları karşılaştırın.



Burada öğrencilerden aynı yayı gören merkez açının ölçüsünün çevre açının ölçüsünün iki katı olduğunu bulmaları beklenir. Daha sonra öğretmen bu bilgiyi tahtaya yazar.

SONUÇ ETKİNLİKLERİ

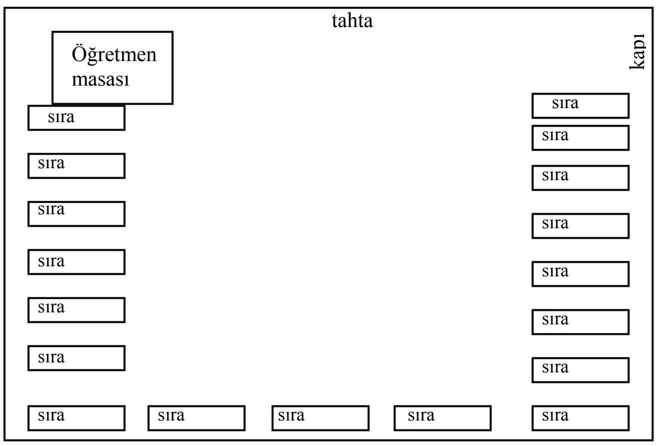
1. Öğrencilerden, gözlerini kapatıp, çevre ve merkez açıyı düşünmeleri istenir.
2. Gruplardan her birinin aşağıdaki durumlardan bir tanesini kendi cümleleri ile açıklamaları istenir;

a. merkez açı ile gördüğü yay arasındaki ilişki
b. birbirine eş yayları gören merkez açılar arasındaki ilişki
c. biri diğerinden büyük yayları gören merkez açılar arasındaki ilişki
d. bir çevre açı ile bu açının gördüğü yay arasındaki ilişki
e. aynı veya eş yayları gören çevre açıların ölçüleri arasındaki ilişki
f. aynı yayı gören merkez açıyla çevre açı arasındaki ilişki

3. Gruplardan her birinin aşağıdaki durumları birer fotoğraf anı ile canlandırmaları istenir.

a. merkez açı
b. yay
c. birbirine eş yayları gören merkez açılar
d. çevre açı
e. aynı veya eş yayları gören çevre açılar
f. aynı yayı gören merkez ve çevre açı

DERS PLANI 14
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 4: Çemberi ve çemberin merkezine farklı uzaklıklardaki doğruları çizebilme
Davranışlar:
D1. Merkezi ve yarıçapı verilen çemberi araç ve gereç kullanarak çizme
D2. Çemberin merkezine olan uzaklığı verilen bir doğruyu çizme
D3. Bir çembere, üzerindeki bir noktadan pergel ve cetvel yardımıyla teğet çizme
D4. Bir çembere, dışındaki bir noktadan pergel ve cetvel yardımıyla teğet çizme
D5. Bir çembere, üzerinde veya dışında verilen noktadan çizilebilecek teğetlerin sayısını söyleyip yazma
Süre: 1 tane
Materyal:
Kullanılan drama teknikleri: Donuk imge, uzman rolü, öğretmenin rol alması, geriye dönüş
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ

1. "Hep birlikte, el ele bir çember oluşturun. Şimdi herkes durduğu yeri değiştirsin. Omuz omuza bir çember oluşturalım. Yine herkes sınıf içinde 20 sn. dolaşsın. Kol kola bir çember oluşturalım. "
2. "Herkes sağına dönsün, çember üzerinde yürüyoruz. Şimdi tam ters yönde yürüyün. Şimdi geri geri ve oldukça yavaş yürüyoruz. Şimdi ileriye doğru ama ağır çekimdeki görüntü gibi yürüyoruz. Şimdi 2 adım ileri, 5 adım geri yürüyoruz."

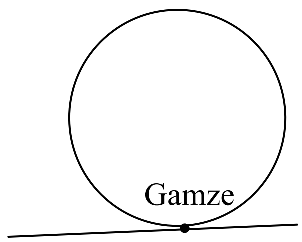
GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen, "Ateş çemberinin dışına bir kütük düştü. Şimdi 5 erli gruplar halinde bu kütüğün düşüş anını bir donuk imge ile canlandırın. " der.
2. Öğretmen, "Hepimiz çizimden sorumlu devlet bakanlığında çalışıyoruz. Ben burada baş çizimciyim. Sizden çemberin a kadar uzağına düşmüş bir kütüğün resmini çizmeniz istiyorum. Bu çizimi size verilen kağıtlara sadece pergel ve cetvel

kullanarak yapmanız gerekiyor" der. "Bu çizimden önce şu soruyu düşünmenizi öneririm; çemberin a kadar uzağını nasıl belirlersiniz?" diye bir ipucu verebilir.

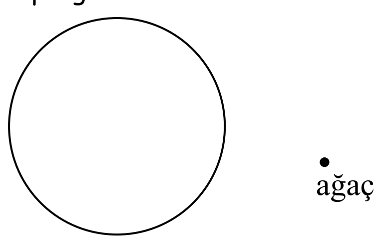
3. Gruplar çizimini bitirince, öğretmen "şimdi çizimlerinizi baş çizimciye anlatma zamanı" diyerek, her grubun sırayla çizimin nasıl yapıldığını anlatmalarını ve çizimi donuk imge olarak canlandırmalarını ister.

4.Öğretmen aşağıdaki resmin çizili olduğu kağıtları öğrencilere dağıtır. "Ateş çemberinde nokta ile gösterilen Gamze ayakta durmaktan yorulmuştur. Gamzenin dayanabilmesi için bir duvar inşa edeceğiz. Yalnız bu duvarın sadece Gamze'nin bulunduğu nokta ile temas etmesini istiyoruz. Bu duvarı elinizdeki kağıda sadece pergel ve cetvel kullanarak çiziniz." der. Burada flashback yapılarak, "Ateş çemberinin etrafına düşen kütüklerin ne şekillerde durabileceklerini fotoğraflarla canlandıralım. Tek noktada temas eden bu düz duvara ne isim veririz?" denir ve öğrencilerin teğet ile ilgili bilgilerini hatırlamaları sağlanır.

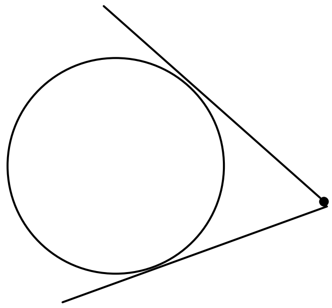


5.Gruplar çizimlerini bitirince baş çizimci olan öğretmene sırayla çizimlerini anlatmaları, ardından oluşan şekli canlandırmaları istenir.Daha sonra öğretmen, bir çembere, üzerindeki bir noktadan sadece 1 tane teğet çizilebileceğini söyler ve tahtaya yazar.

6.Öğretmen, aşağıdaki şeklin çizili olduğu kağıtları gruplara dağıtır. "Kağıtlarda ateş çemberinin yanında nokta ile gösterilen noktada bir kuru ağaç yer almaktadır. Bu ağaç kesildiğinde ateş çemberine teğet olarak düşmesini istiyoruz. Kütüğün düşebileceği yeri sadece pergel ve cetvel kullanarak nasıl çizebilirsiniz?" der.



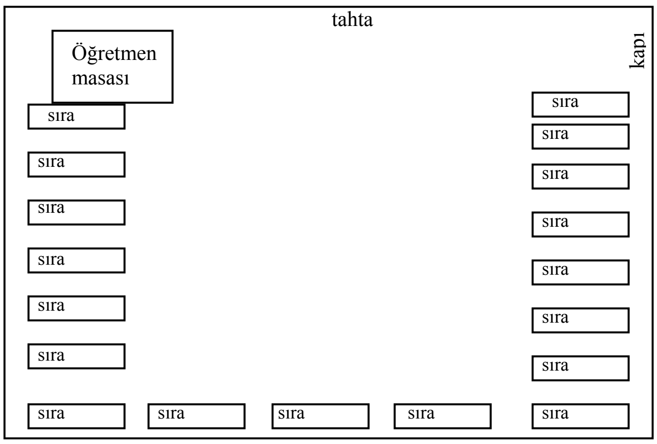
7.Öğrencilerden istenilen çizimi yapmaları beklenir. Daha sonra çizimlerini sırayla anlatmaları ve canlandırmaları için süre verilir.
Burada öğretmen tahtaya bir çembere dışındaki bir noktadan iki tane teğet çizilebileceğini söyler ve aşağıdaki şekli tahtaya çizer.



SONUÇ ETKİNLİKLERİ

1. Bir çembere, üzerindeki bir noktadan kaç tane teğet çizilebileceği sorulur. Öğrencilerin cevaplarını donuk imge ile canlandırmaları istenir.
2. Bir çembere, dışındaki bir noktadan kaç tane teğet çizilebileceği sorulur. Öğrencilerin cevaplarını donuk imge ile canlandırmaları istenir.

DERS PLANI 15
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
Davranışlar:
D1. Bir çemberin uzunluğu ile çapının uzunluğundan faydalanarak, π sayısını bulma
D2. Çemberin çevresi ile yarıçap uzunluğu arasındaki bağıntıyı söyleyip yazma
D3. Yarıçapının uzunluğu verilen çemberin, uzunluğunu hesaplayıp yazma
D4. Uzunluğu verilen bir çemberin yarıçap ve çap uzunluğunu bulup yazma
D5. Bir dairenin alanı ile yarıçap uzunluğu arasındaki bağıntıyı söyleyip yazma
D6. Yarıçap uzunluğu verilen bir dairenin alanını bulup yazma
D7. Çevresinin uzunluğu verilen bir dairenin alanını bulup yazma
D8. Yarıçapı ve merkez açısının ölçüsü verilen bir çemberde, merkez açısının gördüğü yay uzunluğunu hesaplayıp yazma
D9. Merkez açısının gördüğü yay uzunluğu verilen bir çemberin yarıçapını hesaplayıp yazma
D10. Yarıçapı ve merkez açısının ölçüsü verilen bir daire diliminin alanını hesaplayıp yazma
D11. Merkez açısının ölçüsü verilen daire diliminin alanından yararlanarak, dairenin yarıçapının uzunluğunu hesaplayıp yazma
Süre: 3 saat
Materyal:
Kullanılan drama teknikleri: Öğretmenin rol alması
Sınıf yerleşim planı:



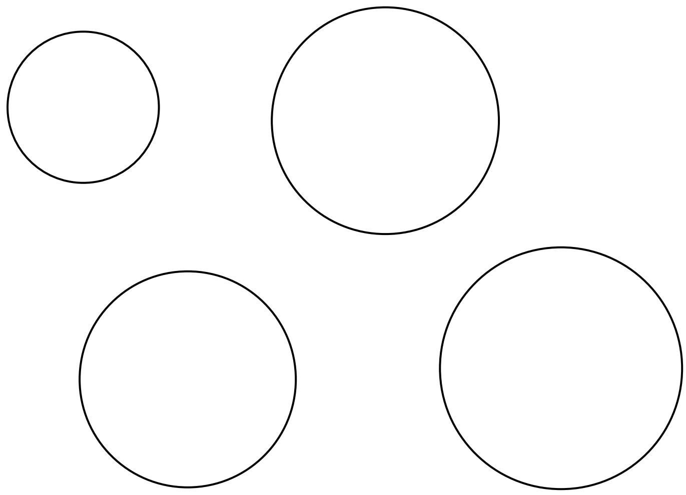
GİRİŞ ETKİNLİKLERİ:
Öğretmen, "Müzik eşliğinde sınıfta dolaşıyoruz. Müziği durdurduğumda 1 tane çember oluşturun. Bu çemberin merkezi neresi olabilir? Tekrar dolaşıyoruz. Müziği durdurduğumda 3 tane çember oluşturun." der. Müziğin sonraki durduruluşlarında 5, 6, 7 çember; sonrasında ise 1, 2 ve 3 daire oluşturmaları istenir. Öğretmen, "Şimdi yine 1 tane daire oluşturuyoruz. Bu daireden 1 çember oluşturun. " der.

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen kamp lideri rolünde "izci arkadaşlar, kampımıza yeni izci arkadaşlarımızın katılacağı haberini aldık bu arkadaşlar için bir çadır kurmamız gerekiyor. Gelecek arkadaşlar çapı 120 cm. olan bir daire şeklinde tabanı olan bir çadır getireceklerini söylediler. Acaba bu çadırın tabanının çevresinin uzunluğu ve tabanın kapladığı alan nedir? Çadırlarını görüp, ölçmeden bunu hesaplayabilir misiniz?" diye sorar.

(Burada öğrencilerden çap-çevre, çap-alan arasındaki ilişkiyi bulmaları beklenmektedir. Öğrencilerin bu ilişkiyi bulmasını kolaylaştırmak üzere aşağıdaki gibi yönergeler verilebilir.)

a) Öğretmen "Büyüklükleri birbirinden farklı olacak şekilde 4 tane çember oluşturun" der. Çemberlerin çevrelerini uzunluklarını nasıl belirleyebileceklerini sorar. Öğrencilerden görüşleri alınır. (Öğrencilerden çevresini adımlarımızla ölçeriz, iplerle ölçeriz gibi cevaplar beklenir).



b) Öğretmen "Şimdi sizden sadece bu çemberlerin yarıçaplarını ölçerek çevrelerini bulmaya çalışmanızı istiyorum. Acaba çevre ile yarıçap arasında bir ilişki olabilir mi?" diye sorar.

c) Burada öğretmen mühendis olarak role girer ve "Aşağıdaki tabloyu kullanmak belki size yardımcı olabilir" diyerek ipucu verir. Öğrencilerin, bu tabloyu gereken ölçümleri yaparak doldurmaları istenir.

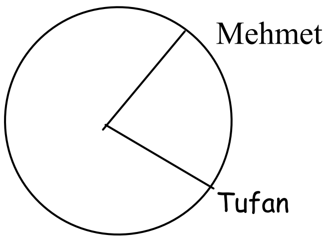
	çevre	çap	
1. ateş çemberi			
2. ateş çemberi			
3. ateş çemberi			
4. ateş çemberi			

d) Öğrenciler tabloyu doldurduktan sonra "Ateş çemberinin uzunluğu 12,56 m. olsaydı, ateş çemberinizin yarıçapının ne kadar olması gerekirdi?" diye sorulur.

Öğrencilerin, bu sorunun cevabını bulabilmeleri için, yarıçapa bağlı olan çevre formülünden yararlanmaları gerekmektedir. Formülü bulmakta zorlanırlarsa, öğretmen yine mühendis rolünde "Arkadaşlar tabloda kullanmadığınız bir kolon var, bu kolona şu an tabloda yer alan veriler arasındaki bir ilişkiyi, yani o veriler arasındaki bir hesaplama sonucunu yazmak işinize yarayabilir" der. "Çevreyle, çap arasında bir ilişki görebiliyor musunuz?", "Çevreyi, çapa bölsek ne olur?" gibi ek sorular sorulabilir.

e) Burada öğrencilerin, çemberin çevresinin, çapının 3.1416.., yani, π katı olduğunu bulmaları beklenmektedir. Öğretmen, "Bir çemberin uzunluğu, çemberin çevresinin uzunluğu demektir. Çemberin uzunluğu, çapı ile π sayısının çarpımına eşittir" der ve tahtaya bu bilgiyi yazar.

f) Mühendis rolündeki öğretmen "Yandaki ateş çemberinde ısınan bölgenin köşelerinde Mehmet ve Tufan bulunmaktadır. Buradaki ateş açısı 90 derece olduğuna göre Mehmet ve Tufan'ın birbirine uzaklığı ne kadardır? " diye sorar. Öğrencilere, gerekli hesaplamayı yapmaları için süre verilir.



g) "Yukarıdaki ateş çemberinde ısınan bölgenin köşelerindeki izciler olan Mehmet ve Tufan'ın birbirine uzaklığı 314 cm ise bu çemberdeki ateş açısı kaç derecedir? "

h) Öğretmen yine mühendis rolünde "Yağmur yağdığında ıslanmamak ve ateşimizi yağmurdan korumak için kullandığımız naylon brandalarımızı, alan ölçen makineye koydum ve makinede hepsinin alanlarını buldum. Alanlar aşağıdaki tablodaki gibidir." der ve tabloyu öğrencilere gösterir.

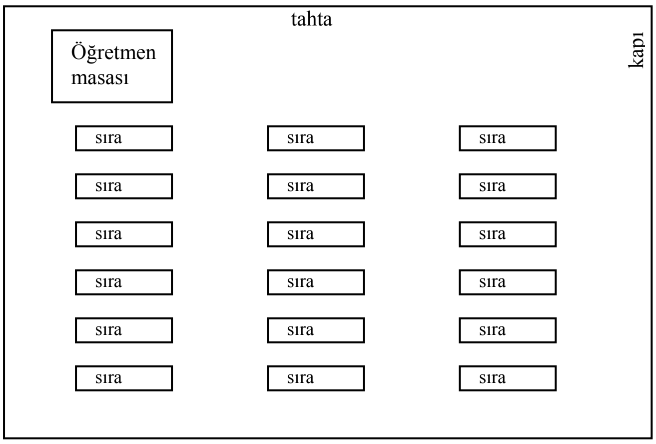
	Alan	Yarıçap	
1. ateş çemberi			
2. ateş çemberi			
3. ateş çemberi			
4. ateş çemberi			

i) "Bu tablodaki bilgilerden yaralanarak, yarıçapı .... (sınıftaki ateş çemberleri dışında bir değer) olan bir ateş çemberini korumak için gereken branda miktarını (dairenin alanını) bulunuz". Burada ek olarak "Çemberin çapı ve alanı arasındaki ilişki ne olabilir? Alan çapın kaç katı?" gibi sorular sorulabilir. Öğrencilerin alanın yarıçapın karesinin π katı olduğunu bulmaları beklenmektedir.

SONUÇ ETKİNLİKLERİ

Öğrencilerle birlikte, konu ile ilgili olarak kitaptaki sorular çözülür.

DERS PLANI 16
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 6: Dik silindirin özelliklerini kavrayabilme
Davranışlar:
D1. Silindirin açık şekline bakarak, yan yüzü ile tabanlarının hangi düzlemsel şekiller olduklarını söyleme
D2. Silindirin yüksekliğini gösterme
D3. Silindirin tabanı ile yanal yüzü arasındaki ilişkiyi söyleme
Süre: 1 saat
Materyal:
Kullanılan drama teknikleri: Rolde hesaplama, donuk imge
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ:
Öğretmen, "Kamp yerinde eğlenceli vakit geçirmeye devam ediyorsunuz. Şimdi bir çember oluşturup el elel tutuşalım. Kamp yerine bir kuş girdi, kuşu gözlerinizle takip edin. Kuş uçuyor, bir ağaca kondu, ağaçtan uçtu derenin kenarına kondu, dereden su içiyor. Kamp alanına, yuvarlana yuvarlana, bir teneke varil geldi, şimdi yuvarlanan varili gözlerimizle takip edelim. Nasıl ilerlediğini anlamaya çalışalım. Kamp alanında bir ağaç kütüğü gördünüz. Kütüğü gözlerinizle inceleyin. Nasıl şekillerden oluştuğunu anlamaya çalışın. Şimdi bu ağaç kütüğü olduğunuzu düşünün. Ağaç kütüğü olarak, bedeninizin nasıl olduğunu düşünün. Şimdi herkes bir ağaç kütüğü gibi dursun ve bu şekilde bir süre donsun." diyerek öğrencilerin sonraki etkinlikler için hazır olmasını sağlar.

GELİŞTİRME ETKİNLİKLERİ
1. Öğretmen, "Kamp yerine uzaylılar geldiler ve uzaylılar arkadaşlarınızdan birini uzay aracına hapsettiler. Uzay aracı bu cisme (silindir) benziyor. İzci arkadaşınızı bu uzay aracından çıkarmak için şekli incelemeli, şekille ilgili olarak, uzaylıların sizden isteyeceği görevleri yerine getirmelisiniz." der.
2. Öğretmen, "Her oba kendine verilen cismin özelliklerini bulsun ve cisimle ilgili bir rapor yazsın. Raporda cismi oluşturan geometrik şekiller ve bu şekillerin

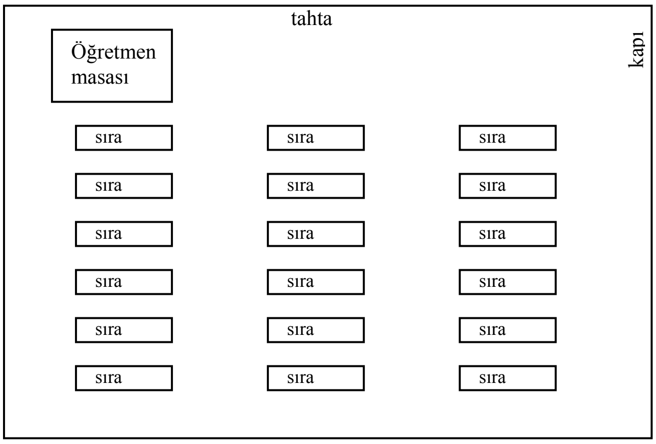
ölçüleri verilmelidir." diyerek, öğrencilerin rolde yazmalarını ister ve öğrencilere raporlarını bitirmeleri için süre verir.

a. Verilen sürenin sonunda, gruplar raporlarını öğretmene iletirler. Daha sonra öğretmen grupların raporunu sunmalarını ister.

SONUÇ ETKİNLİKLERİ

Öğrencilerin, evde birer silindir kutu yapmaları, bu kutuları nasıl yaptıklarını anlatan ve çizimler içeren bir afiş hazırlamaları istenir.

DERS PLANI 17
ÜNİTE 6 ÇEMBER, DAİRE VE SİLİNDİR
HEDEF 7: Dik silindirin alanını ve hacmini hesaplayabilme
Davranışlar:
D1. Silindirin taban alanlarını veren bağıntıyı söyleyip yazma
D2. Silindirin yanal alanını veren bağıntıyı söyleyip yazma
D3. Silindirin tüm alanını veren bağıntıyı söyleyip yazma
D4. Taban yarıçapı ve yüksekliği verilen bir silindirin yanal alanını hesaplayıp yazma
D5. Silindirin tüm alanını hesaplayıp yazma
D6. Silindirin hacmini veren bağıntıyı söyleyip yazma
D7. Taban alanı ile yüksekliği verilen silindirin hacmini hesaplayıp yazma
D8. Hacim formülündeki değerlerden herhangi ikisi verildiğinde, üçüncü değeri hesaplayıp yazma
Süre: 2 saat
Materyal: Kağıt, kalem
Kullanılan drama teknikleri: Rolde hesaplama, toplantı düzenleme
Sınıf yerleşim planı:



GİRİŞ ETKİNLİKLERİ:

Öğretmen, "Müzik eşliğinde sınıfta dolaşıyorsunuz. Ben müziği durdurduğumda 2 tane çember oluşturun. Tekrar dolaşıyorsunuz. Müzik durduğunda, 3 tane, eşit sayıda öğrenciden oluşan çember oluşturun. Şimdi, bu çemberlerdeki kişiler isimlerinin ilk harfine göre sıralansın. Bakalım hangi grup daha önce bitirecek. Yine sınıf içinde dolaşıyoruz. Müziği durdurduğumda bir daire oluşturun. Müziği durdurduğumda bir silindir oluşturun. Müziği durdurduğumda bir tane silindiri oluşturan geometrik şekilleri oluşturun." der.

GELİŞTİRME ETKİNLİKLERİ

1. Öğretmen, "Arkadaşınızı kurtarabilmek için uzaylıların sizden yapmanızı istediği ikinci görev, bu cismi, size verecekleri renkli kağıtlar ile kaplamanız. Yalnız kaplama işi sanıldığı kadar kolay değil. Kaplama kağıdını uzaylılardan isteyeceksiniz. Uzaylıların sizden bekledikleri, sizdeki cismi kaplamak için gereken renkli kağıdın

tam ölçüsünü vermeniz. Size gereken kağıdın tam ölçüsünü söylerseniz ve bu miktarı nasıl bulduğunuzu anlatan bir rapor yazarsanız, size gereken kağıdı ve gerekli yapıştırıcıyı verecekler. Siz cismi kapladığınızda görev tamamlanmış olacak ve arkadaşınızı kurtaracaksınız.

Bu görev için aşamalar:

a. Cismin tabanları için ne kadar renkli kağıda ihtiyacınız var?

b. Cismin yanları için ne kadar renkli kağıda ihtiyacınız var?

c. Cismin tamamı için ne kadar kağıda ihtiyacınız var?

Bunları içeren bir rapor yazınız. Raporun sonuna size r=a ve h=b olan bir silindir verilseydi kaplamak için ne kadar kağıda ihtiyaç duyardınız, hesaplayıp yazınız." der.

2. Kampa gelirken sadece 1 varil su getirmişsiniz. Varilinizin boyutları r=1 dm., h=10 dm. Varile baktığınızda, varildeki suyun, tam olarak yarısının bittiğini görüyorsunuz. Obadaki herkes günde 1 litre su içiyor. Bu durumda, acaba varildeki su, obanıza kaç gün yeter? (İpucu: varilde ne kadar su kalmış? Bunu nasıl ölçersiniz?)

SONUÇ ETKİNLİKLERİ

1. Silindirin alan formülü üzerinde konuşulur.
2. Silindirin hacminin nasıl hesaplanacağı tekrar vurgulanır.

APPENDIX L

EVALUATIONS OF LESSON PLANS IN TERMS OF THE DRAMA BASED EDUCATION CRITERIA

Lesson Plan	1
Social Metaphor	Analogy with scissors, TV program producer
Make Believe Play	Role of TV program producer
Group work	Groups of four, in listing and forming angles in daily life, groups of six in TV program producing
The students' role	Walking by drawing zigzags, forming angle by using their body, imagining scissors, forming scissors (angle), exploring the properties of scissors (vertical and adjacent angle) In producing TV program, deciding how they could present the topic, criticizing the others group presentation, Communication: In TV program producing and forming scissors expressing, discussing, negotiating and justifying ideas, trying to persuade the others s-t: teachers question,
The teacher's role	Facilitating to develop, express and communicate ideas within and between groups, to create original positions for TV program Participant: As an evaluator of the TV program Foster communication: By asking questions to other groups when a group was presenting
Warm-up activities	Walking in the classroom by drawing zigzag, forming angles by using their body
Drama techniques	Still image, meeting, TV program, teacher in role
Dramatic moments	Tension of time in preparing TV program
Quieting activities	Presenting TV program

Lesson Plan	2
Social Metaphor	Analogy with violin string, analogy with the meanings of the words "*komşu*" and "*yöndeş*"
Make Believe Play	Role of TV program producer
Group work	Groups of 7-34 while forming lines, groups of six, in TV program producing
The students' role	Walking in the classroom, forming 3 lines in different positions by their body and rope, forming violin string, organizing their positions in forming an angle by altogether, being an angle at the intersecting point of two lines Communication: İn TV program producing and forming angles expressing, discussing and justifying ideas
The teacher's role	Facilitator: Facilitating to find different positions for three lines, develop, express and communicate ideas Participant: As an evaluator of the TV program Foster communication: By forwarding students questions to whole class, by asking questions challenge questions like "are these following situations constitute different positions for three lines? A) two parallel lines intersecting with other line by an arbitrary angle and B)two parallel lines intersecting with another line by right angle"
Warm-up activities	Walking in the classroom, forming one two or three angle(s) altogether, forming three angles by using ropes in different positions
Drama techniques	Still image, meeting, TV program, teacher in role
Dramatic moments	Forming 3 different lines in a position different than the previous, tension of time in preparing TV program
Quieting activities	Presenting TV program

Lesson Plan	3
Social Metaphor	Analogy of finding the shortest rode between two particular place, relation with the students one of their favorite hero; Spider-Man
Make Believe Play	The role of in charge of the mission given by the Spider-Man
Group work	Working in groups while doing the instruction giving by the mission
The students' role	Active participant: Being a tree in warm-up activities, forming triangles and their mediums, altitude, angle bisectors by ropes and their bodies, working to remove the Spider-Man's problems Communication: While drawing in groups, expressing, discussing ideas with group members, discussing and justifying their ideas, while whole class discussion criticizing and advising the others
The teacher's role	Facilitator: Facilitating to explore, develop, express and communicate ideas in each step of the lesson Foster communication: Asking for suggestions to their friends when they were criticizing the others work, asking questions, and forwarding the students questions to the classroom.
Warm-up activities	Becoming a tree from a seed in the soil (being a seed, growing by water and food, becoming a small plant, growing slowly to be a three, as a three feeling the winds, the animals on the three, etc.)
Drama techniques	Letters, writing (drawing) in role
Dramatic moments	Interest with the coming letters, overcoming an obstacle spider man has faced
Quieting activities	Forming triangles and their mediums, altitude, angle bisectors by ropes and their bodies.

Lesson Plan	4
Social Metaphor	Relation with the dimension of a triangle house (Checking the numbers in order to find the measure of constructible house)
Make Believe Play	The role of in charge given by NASA
Group work	Working in groups of four while studying to overcome the problem posing by the NASA representative
The students' role	Active participant: In warming-up activities, performing the experiments by straws and rope, discussing the reasons, speculating an idea related as a solution in the role of in charge given by NASA Communication: While working in groups, expressing, criticizing, discussing ideas with group members, discussing and justifying the idea they found
The teacher's role	Facilitator: Giving clue when they didn't realize the relationship between length of a side and the difference of the length of other two sides in a triangle Participant: As a representative of NASA Foster communication: Asking questions, giving clue
Warm-up activities	Counting from 1 to 10 or 10 to 1 in different context (counting coins, in a boxing ring, counting the last ten seconds of a space rocket etc…)
Drama techniques	Mantle of expert, meeting, teacher in role
Dramatic moments	Overcoming a problem posing by the representative of NASA
Quieting activities	Solving questions

Lesson Plan	5
Social Metaphor	Analogy with the irrigation of a garden by jet of waters
Make Believe Play	A irrigation by jet of water, the role of in charge of writing a letter to a child from underdeveloped country
Group work	Working in groups while forming a triangular area and irrigating water jets
The students' role	Active participant: Being a water jet irrigating a garden, writing letters Communication: Expressing, discussing ideas with group members
The teacher's role	Facilitator: Facilitating to explore, develop, express and communicate ideas in each step of the lesson Foster communication: By asking questions, forwarding the students questions to the classroom, making students question the ideas suggested by a classmate, reinforcing any idea to encourage communication
Warm-up activities	Becoming a flower needed water in a garden
Drama techniques	Letters, still image
Dramatic moments	
Quieting activities	Writing letter to a child from an underdeveloped country

Lesson Plan	6
Social Metaphor	--
Make Believe Play	The role of a students whose friend missed a lesson
Group work	Working in pairs during warm-up activities, working in groups of 3 -10 while forming different polygons
The students' role	Active participant: Drawing polygons, forming polygons by ropes and their body Communication: While forming polygons, expressing, discussing, criticizing and justifying ideas, asking questions to the other group
The teacher's role	Facilitator: During the lesson each step of the lesson plan students can be facilitated to explore, develop, express and communicate ideas, concept Foster communication: Asking questions when students formed a shape, encouraging students to ask questions related with other groups' shape and telephone conversation
Warm-up activities	Coloring a picture involves polygons
Drama techniques	Telephone conversation, still image
Dramatic moments	Helping a friend who missed a lesson
Quieting activities	Summarizing the concept of polygon

Lesson Plan	7
Social Metaphor	Analogy with a Pentagon building and its angle
Make Believe Play	The role of a tourist visiting the Pentagon, American Defense Ministry
Group work	Working all class
The students' role	Active participant: Forming different polygons by using their body, being a tourist visiting pentagon, obtaining data and filling the table Communication: Speculating, expressing, discussing ideas
The teacher's role	Facilitator: Giving clue when they could not find total interior angle logically Participant: As a security guard of a Pentagon building Foster communication: Asking questions, giving a clue, encouraging to speculate an idea
Warm-up activities	Forming different polygons hand in hand, shoulder to shoulder
Drama techniques	Mantle of expert, writing (drawing) in role, teacher in role
Dramatic moments	Trying to protect from a terrorist attack, tension of time
Quieting activities	Solving questions

Lesson Plan	8
Social Metaphor	Analogy with visiting a country and a country visited by tourist
Make Believe Play	A role of a tourist visiting a country, a country visited by tourist, introducing a country
Group work	Working in pairs in warm-up activities, working in groups while discovering the properties of different quadrilateral
The students' role	Active participant: Drawing polygons, forming polygons by ropes and their body, measuring angles, sides of the quadrilaterals, computing and comparing some properties of quadrilaterals Communication: While working for discovering their country expressing, discussing ideas with group members, while presenting their works criticizing and advising the other group
The teacher's role	Facilitator: Asking questions to facilitate them realize an important point like; "Is a rectangle also be a parallelogram?" "Is the verse also true?" Foster communication: Asking questions, encouraging to ask questions to the other groups, friends
Warm-up activities	Forming different polygons by using their body
Drama techniques	TV program, meeting, writing (drawing) in role
Dramatic moments	
Quieting activities	Summarizing the properties of quadrilaterals

Lesson Plan	9
Social Metaphor	Analogy with plan of lands
Make Believe Play	The role of the engineers from the Ministry of Forestry and the role of press members
Group work	Working in group of four as an engineer
The students' role	Active participant: Drawing quadrilaterals by finger, nose, knees, elbows or navel in warm-up activities, measuring and computing while working on the mission given by the head of the engineers Communication: While calculating the number of threes can be planted, discussing about sides, perimeters of quadrilaterals with group members, discussing, during the presentation to the press members discussing as press members and engineers, as press members criticizing and advising the engineer group
The teacher's role	Facilitator: Facilitating to discover the perimeter of quadrilaterals, and communicate ideas in each step of the lesson Participant: As a head of the engineers of the Ministry of Forestry Foster communication: By asking questions, forwarding the students questions to the classroom.
Warm-up activities	Drawing imagining squares, deltoids, rectangles, diamonds, parallelograms and rhombuses in air, on another students back, on the wall either by finger, nose, knees, elbows, or navel.
Drama techniques	Mantle of expert, meeting, teacher in role
Dramatic moments	Overcome the obstacle posed by the head of the engineers in The Ministry of Forestry
Quieting activities	Summarizing perimeter of quadrilaterals

Lesson Plan	10
Social Metaphor	Analogy with a game
Make Believe Play	The role of players
Group work	Working in groups of four while playing the game of "the biggest power board"
The students' role	Active participant: Playing the game of snatching place, playing the game of "the biggest power board" Communication: While calculating the power of the boards (areas) speculating and discussing ideas with group members
The teacher's role	Facilitator: Giving clues of "begin with the triangular area (6th board), then use the same idea to calculate the others" Participant: Examining Committee member Foster communication: By asking questions
Warm-up activities	Playing the game of "snatching place" (using the names of quadrilaterals)
Drama techniques	Teacher in role
Dramatic moments	Finding the correct answer of the challenged question to win the game
Quieting activities	Summarizing the area of the special quadrilaterals

Lesson Plan	11
Social Metaphor	Analogy with a scouting camp setting
Make Believe Play	The role of camping scouts
Group work	Working in group as scouts
The students' role	Active participant: Behaving as a scout in a camp, work on a problems scout facing in the camp like getting the unequal heat from the fire, protecting fire and themselves from the rain while getting equal heat Communication: While drawing in groups, discussing about finding equal length from the camp fire, how to protect from rain without changing equidistant places around the camp fire
The teacher's role	As a scout leader, facilitated to discover importance of being equ-distant from a point, and difference between ring and circle, asked questions, forwarding the students questions to the classroom like "Is a ball count as a circle?", "Is every plate can count as a circle?", "What properties should be satisfied in order to be a circle?"
Warm-up activities	Walking and singing in a line as if going to a scout camp, talking in the role of camping scouts
Drama techniques	Still image, mantle of expert, teacher in role
Dramatic moments	Tension of the camping condition: Overcoming the obstacles of finding the way of getting the equal heat from the fire Tension of the rain: Finding the way of protecting fire and themselves from the rain while getting equal heat from the fire
Quieting activities	Students were asked to state five objects in the shape of ring and circle, given time to examine the given hullo hops, asked to form a ring, circle, asked about the positions of the objects put exterior or interior region of the circle

Lesson Plan	12
Social Metaphor	Analogy with a scouting camp setting
Make Believe Play	The role of engineers working in a project in the Ministry of Forestry and camping scouts
Group work	Working in group as engineers, scouts
The students' role	Active participant: Drawing imagining circles in warm-up activities, measuring arc, chord, comparing the measurement, finding rules while working as if the engineers Communication: While forming different positions of an cut three and a fire circle as still image discussing and arranging the places to stand, while working as engineer to find relations between ,arc, chord speculating and discussing ideas
The teacher's role	Facilitator: Facilitating to discover the different positions of a line and circle and relations between arc and chord Participant: As a project director and the scout leader Foster communication: Asking questions
Warm-up activities	Drawing imagining circles by using pinky finger, shoulder, elbow, palm, head, eye, nose ..etc.
Drama techniques	Still image, writing in role, teacher in role
Dramatic moments	Finding the different positions of an cut three and a fire circle in order to protect camping scouts
Quieting activities	Summarizing different positions of cut three and fire circle by forming them with their bodies (summarizing different positions of a line and a circle)

Lesson Plan	13
Social Metaphor	Analogy with a scouting camp setting and the possible problems in camp area
Make Believe Play	The role of camping scouts, scout leader
Group work	Working in group in the role of camping scouts, scout leader
The students' role	Active participant: Walking on an imagined ring, forming circles, trying to save the energy of fire when some scouts gone while protecting the diameter of the fire circle Communication: While working to find a way to use fire more effective when some scouts gone, speculating and discussing ideas
The teacher's role	Facilitator: Facilitating to discover how to save the energy of fire when some scouts gone in the condition of protecting the diameter of the fire circle Participant: As a head of the scout leader Foster communication: Forwarding the students suggestions for fire saving problem to the classroom to discuss, e.g. if student suggest to build smaller fire, asking the whole class "what will happen if we build smaller fire?"
Warm-up activities	Walking on an imagined ring in different emotional mood, forming circles
Drama techniques	Still image, meeting, teacher in role
Dramatic moments	Trying to save the energy of fire when some scouts gone while protecting the diameter of the fire circle
Quieting activities	Summarizing the lesson by forming central angle, arc, inscribed angle

Lesson Plan	14
Social Metaphor	Analogy with a scouting camp setting and the possible problems in camp
Make Believe Play	The role of drawers working in the ministry
Group work	Working in groups while forming a tangent as a still image (constructed by three to a fire circle)
The students' role	Active participant: Forming a ring hand in hand, shoulder by shoulder, walking on a imagined ring forward and backward, working in the role of grapier Communication: While trying to form tangents discussing and arranging the places to stand, while working as engineer to find relations between ,arc, chord speculating and discussing ideas
The teacher's role	Facilitator: Facilitating to discover how to draw a tangent to a circle from an outside point and a tangent to a circle from a point on the circle Participant: As a head of grapier Foster communication: Asking questions
Warm-up activities	Forming a ring hand in hand, shoulder by shoulder, walking on an imagined ring forward and backward
Drama techniques	Still image, mantle of expert, teacher in role, flashback
Dramatic moments	Drawing the construction asked by the head of the project from the Ministry
Quieting activities	Forming tangent to a circle from an outside point and tangent to a circle from a point on the circle as a still image

Lesson Plan	15
Social Metaphor	Analogy with a scouting camp setting and the possible problems in camp
Make Believe Play	The role of camping scouts
Group work	Working in group of four as scouts
The students' role	Active participant: Forming rings and circle by using their body, estimating its center, measuring, computing to find the circumference and area Communication: While finding the circumference and area of circle suggesting and discussing ideas
The teacher's role	Facilitator: Facilitating to discover the circumference and area of circle Participant: As a scout leader Foster communication: Asking questions
Warm-up activities	Forming rings and circle by using their body, estimating the location of its center
Drama techniques	Teacher in role
Dramatic moments	Overcome the obstacle posed by the scout leader
Quieting activities	Solving questions

Lesson Plan	16
Social Metaphor	Analogy with a scouting camp setting
Make Believe Play	The role of camping scouts working for saving their friend
Group work	Working in group as scouts
The students' role	Active participant: Following bird flying, drinking water etc, a barrel (a cylinder shape) rolling in the camp are by using eyes in warm-up activities, measuring the parts of a cylinder, summarizing area of a cylinder, forming a cylinder working to find the correct answer of the challenged question given by the aliens Communication: While working to save their friend, discussing and justifying ideas
The teacher's role	Facilitator: Facilitating to discover the parts of cylinder Foster communication: By asking questions
Warm-up activities	Following a bird flying, drinking water etc, a barrel (a cylinder shape) rolling in the camp area by using eyes
Drama techniques	Writing (computing) in role, Still image
Dramatic moments	Finding the correct answer of the challenged question asked by the aliens
Quieting activities	Summarizing parts of a cylinder, forming a cylinder

Lesson Plan	17
Social Metaphor	Analogy with a scouting camp setting
Make Believe Play	The role of camping scouts working for saving their friends
Group work	Working in group of four as scouts
The students' role	Active participant: Forming a ring in the correct order of the first letter of their name, forming shapes consisting of a cylinder, trying to find the correct answer of the challenged question given by the aliens Communication: While working to save their friend, discussing and justifying ideas
The teacher's role	Facilitator: Facilitating to discover the circumference and area of cylinder Foster communication: By asking questions, forwarding the students questions to the classroom.
Warm-up activities	Forming a ring in the correct order of the first letter of their name, forming shapes consisting of a cylinder
Drama techniques	Writing (computing) in role, meeting
Dramatic moments	Finding the correct answer of the challenged question given by the aliens
Quieting activities	Summarizing the area and volume of a cylinder

APPENDIX K

TREATMENT VERIFICATION FORM

Öğretmene Bilgi:
7-A ve 7-B sınıflarında, araştırmacı Asuman Duatepe tarafından işlenen açılar çokgenler, çember ve daire konulu derslerde sizde bulundunuz. Bu derslerde takip edilen ders planları ekte size verilmiştir. Bu ders planlarına bakarak, işlenen derslerle ilgili olarak aşağıdaki tabloyu doldurunuz. Tabloyu doldurmak için, her ders için 0 ile 5 arasında bir not vermeniz gerekmektedir. 1 puan, "İşlenen dersin ekteki ders planlarıyla ilgisi yok" anlamına gelmektedir. 5 puan ise "Dersler, aynen ders planında olduğu gibi işlendi" anlamına gelmektedir. Lütfen her ders için 0 ile 5 puan arasında bir dereceleme yaparak puan veriniz.

Lesson Plan No	0	1	2	3	4	5
1						
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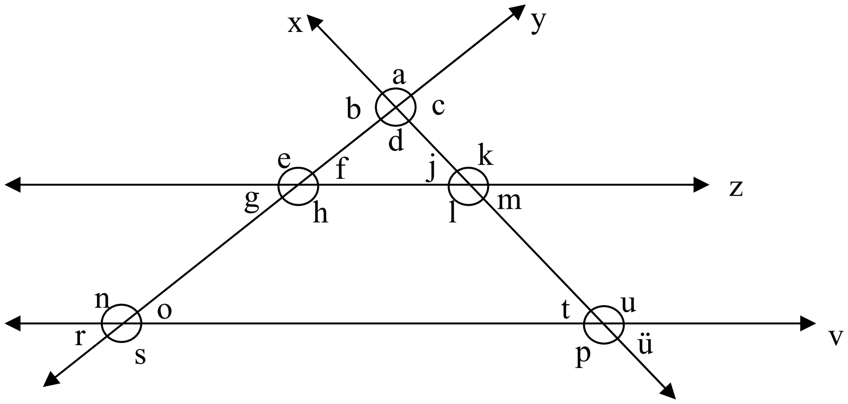
APPENDIX L

THE DRAFT FORM OF ANGLES AND POLYGONS ACHIEVEMENT TEST

1. Üç doğru birbirine göre kaç değişik şekilde bulunabilir? Çiziniz.

2. Aşağıdaki şekilde x, y, z ve v doğruları ve bu doğrular arasında kalan açılar verilmiştir. Bu doğrulardan v ile z doğruları birbirine paraleldir.

b) Bu doğrular arasında kalan açılardan yöndeş olanları yazınız.
c) Bu açılardan ters olanları yazınız.
d) Bu açılardan komşu olanları yazınız.
e) Bu açılardan iç ters olanları yazınız.
f) Bu açılardan dış ters olanları yazınız.
g) Bu açılardan ölçüleri birbirine eşit olanları yazınız.

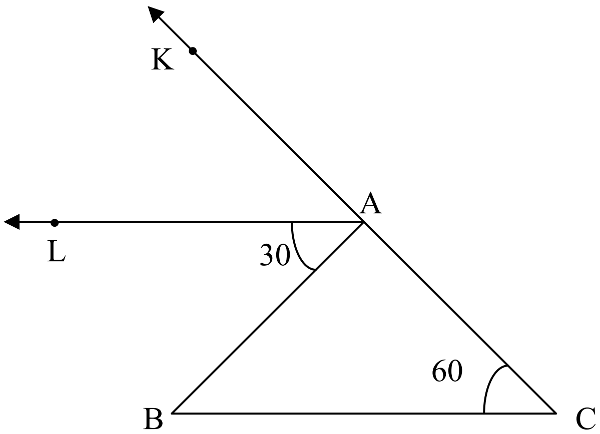


3. Aşağıdaki seçeneklerde verilen kenar uzunlukları ile üçgen çizilip çizilemeyeceğini nedenini belirterek yazınız.
a) 2, 5, 7 b) 9, 2, 6 c) 8, 5, 5 d) 2, 6, 2

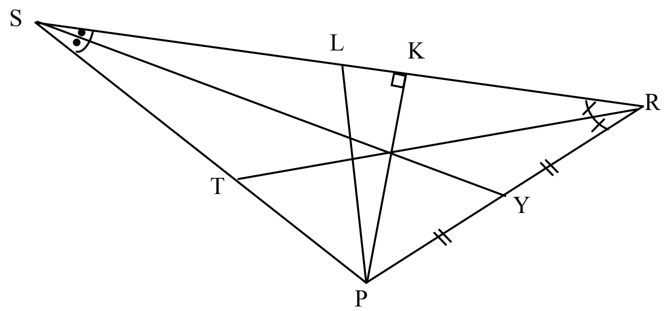
4. Bir ABC üçgeninde A açısının ölçüsü 35°, B açısının ölçüsü 55° ise a, b ve c kenarlarının uzunluklarını büyükten küçüğe doğru sıralayın.

5. Bir ABC üçgeninde kenar uzunlukları a = 12 cm, b = 17 cm ve c = 10 cm olarak veriliyor. Bu üçgenin açılarını büyükten küçüğe sıralayınız. Sıralamanın nedenini açıklayınız.

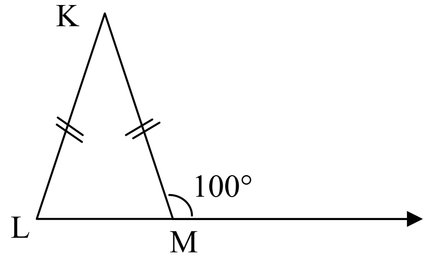
6. Aşağıdaki şekilde [BC] // [AL, ACB açısının ölçüsü 60° ve BAL açısının ölçüsü 30°dir. Buna göre
a. KAL açısı kaç derecedir?
b. ABC açısı kaç derecedir?
c. BAC açısı kaç derecedir?



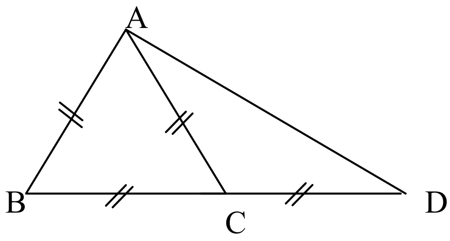
7. Aşağıda SRP üçgeni verilmiştir. Şekilde yer alan L, K, T ve Y noktaları üçgen üzerinde yer almaktadır. Bu üçgende
s(RSY) = s (YSP)
s(SRT) = s(TRP)
|SR| ⊥ |PL|
|SL| = |RL|
|RY| = |YP|
bilgileri verilmektedir. Buna göre bu şekilde gördüğünüz SPR üçgenine ait
a. Kenarortay ya da kenarortayları yazınız. Bu doğru parçası ya da parçalarının neden kenar ortay olduklarını açıklayınız.
b. Açıortay ya da açıortayları yazınız. Bu doğru parçası ya da parçalarının neden açıortay olduklarını açıklayınız.
c. Yükseklikleri yazınız. Bu doğru parçası ya da parçalarının neden yükseklik olduğunu açıklayınız.



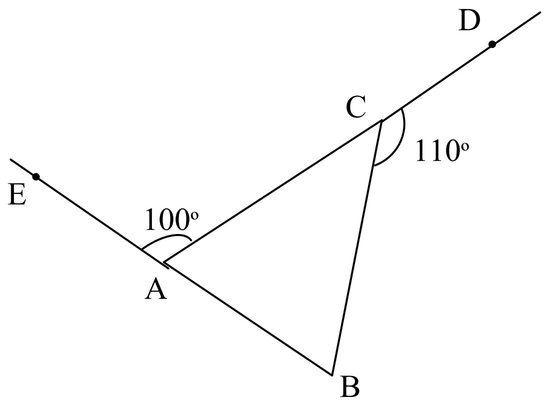
8. Yandaki şekilde |KL| = |KM| ve M açısının ölçüsü 100° dir.
K açısının ölçüsünü hesaplayınız.



9. Aşağıdaki şekilde |AB| = |BC| = |AC| = |CD| dir. Bu durumda ACD üçgeninin açılarının ölçülerini hesaplayınız.



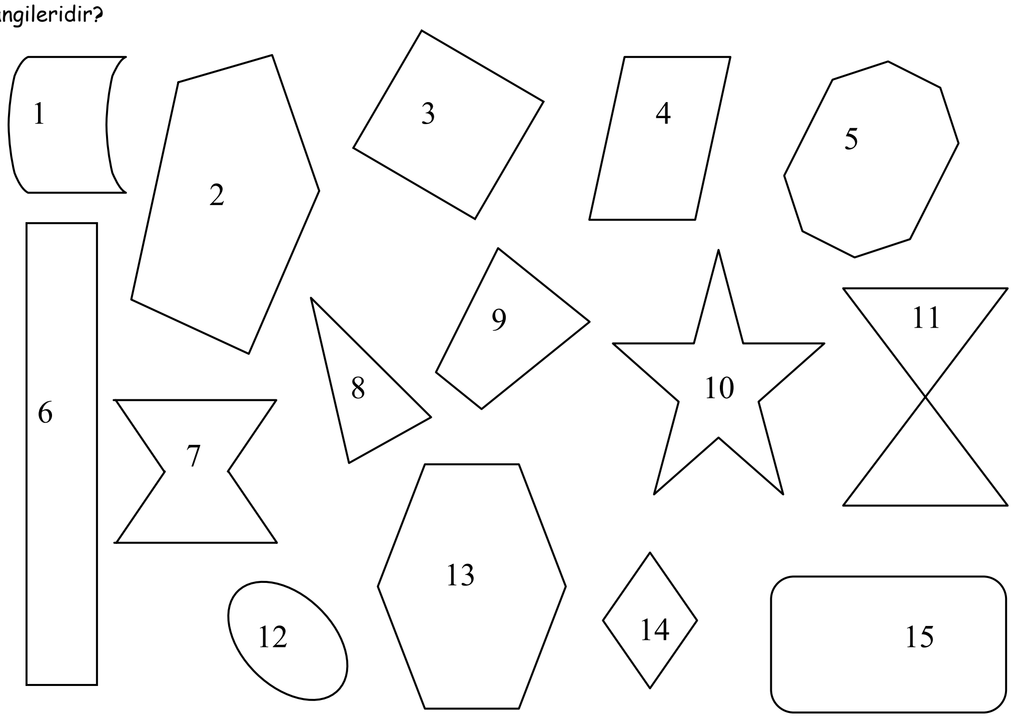
10. Aşağıda verilen şekilde DCB açısının ölçüsü 110°, EAC açısının ölçüsü 100° ise CBA açısının ölçüsünü bulunuz.



11. Bir ABCD dörtgeninde A açısının ölçüsü 65°, B açısının ölçüsü 40° ve C açısının ölçüsü 90° ise a. D açısının ölçüsü nedir?

b. A, B, C ve D köşelerindeki dış açılarının ölçüleri kaçar derecedir?

12. a) Aşağıdaki şekillerden çokgen olanlar hangileridir? b) Aşağıdaki şekillerden çokgen olmayanlar hangileridir?

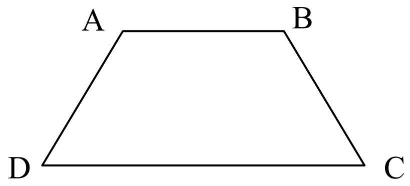


13. Kare ve eşkenar dörtgenin benzer ve farklı yanları nelerdir?

14. Paralelkenar ve dikdörtgenin benzer ve farklı yanları nelerdir?

15. Köşegenleri birbirini ortalayan dörtgenler hangileridir? Yazınız.

16. Aşağıdaki ikizkenar yamukta |AB| = |AD| = 10 cm ve |CD| = 15 cm olduğuna göre Bu yamuğun çevresini hesaplayınız.

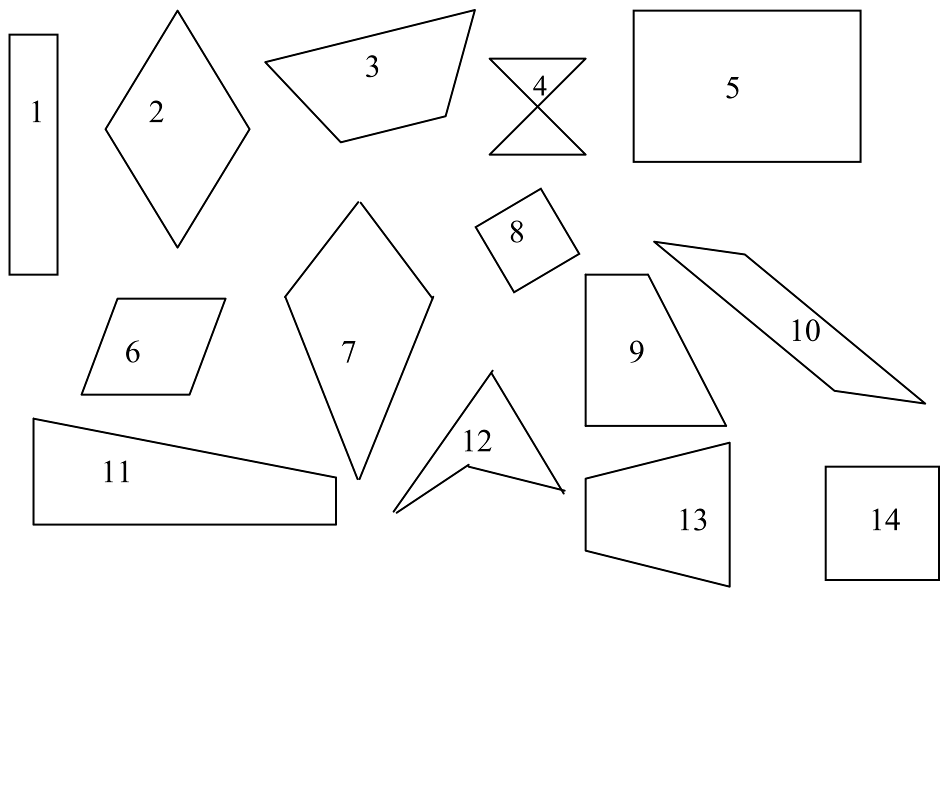


17. Bir kenarının uzunluğu 40 m olan kare şeklindeki bir arazi ve bir kenarının uzunluğu yine 40 m olan eşkenar dörtgen büyüklüğünde başka bir arazi var. Bu arazilerin çevresi dikenli tel ile çevrilmek isteniyor. Hangi araziyi çevirmek için daha çok tel gerekir? Neden?

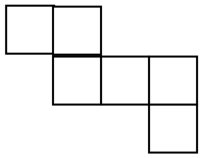
18. Deltoit şeklindeki bir arazinin çevresini hesaplamak için bu araziye ait ne gibi bilgileri bilmemiz gerekir? (çizim yapmak işinizi kolaylaştırabilir?)

19. Kenar uzunlukları tamsayı olacak şekilde alanı 100 birim kare olacak kaç tane dikdörtgen çizilebilir? Çizilebilecek dikdörtgenleri kenar uzunluklarını belirterek yazınız.

20. a. Aşağıdaki şekillerden hangisi ya da hangileri karedir? Neden?
b. Aşağıdaki şekillerden hangisi ya da hangileri dikdörtgendir? Neden?
c. Aşağıdaki şekillerden hangisi ya da hangileri eşkenar dörtgendir? Neden?
d. Aşağıdaki şekillerden hangisi ya da hangileri paralelkenardır? Neden?
e. Aşağıdaki şekillerden hangisi ya da hangileri yamuktur? Neden?
f. Aşağıdaki şekillerden hangisi ya da hangileri deltoittir? Neden?



21. Aşağıda özdeş karelerden oluşan bir şekil verilmiştir. Bu şeklin alanı 294 cm^2 dir. Şeklin kenar uzunluğunu bulunuz.

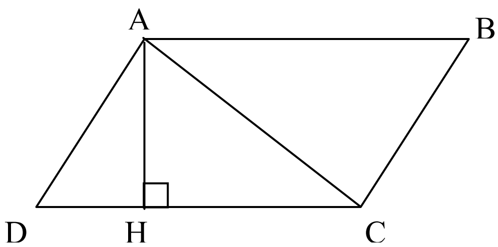


22. Aşağıda verilen eşkenar dörtgenin köşegenleri e = 12 cm ve f = 4 cm dir. Alanı bu eşkenardörtgene eşit olacak şekilde eşkenar dörtgenler oluşturun ve bu eşkenar dörtgenlerin köşegen uzunluklarını yazın.

23. Aşağıda ABCD paralelkenarında $[AH] \perp [DC]$ ve $|AB| = 8$ cm, $|AH| = 4$ cm dir. Buna göre aşağıdaki soruları cevaplayınız.

a) Paralelkenarın alanı kaç cm^2 dir?

b) ABC üçgeni ile ABCD paralelkenarının alanı arasındaki ilişki nedir?



24. Alanı 40 cm^2 olan bir yamuğun yüksekliği 10 cm dir.

a) Tabanları toplamı kaç cm dir?

b) Alt tabanın uzunluğu üst tabanın uzunluğunun 2 katından 1 cm fazla olduğuna göre taban uzunluklarını bulunuz.

APPENDIX M

THE DRAFT OF CIRCLE AND CYLINDER ACHIEVEMENT TEST

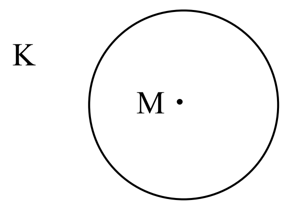
1. Çember ile daire arasındaki fark nedir? Çember ve daireye örnekler veriniz.

2. Bir çember çizip üzerinde yarıçapını gösteriniz. Başka bir yarıçap daha çizilebilir mi? Açıklayınız.

3. M merkezli, 4 cm. yarıçaplı bir çember ile |MA| = 3 cm, |MB| = 5 cm ve |MA| = 4 cm olan A, B ve C noktaları veriliyor.

a. Bu duruma uyan bir şekil çiziniz.
b. A, B ve C noktalarının çembere göre konumlarını belirtiniz.

4. Aşağıda merkezi M ile gösterilen bir çember ve bu çemberin dışında bir K noktası verilmiştir. K noktasından geçen ve bu çembere teğet olan kaç tane doğru çizilebilir? Çiziniz.



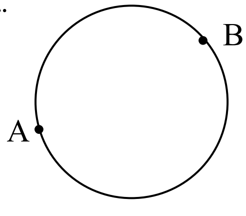
5. Yarıçap uzunluğu 6 cm olan bir çemberin, |AB| = 11 cm, |CD| = 9 ve |EF| = 7 olacak şekilde 3 tane kiriş çiziliyor.

a. Bu kirişlerin yaylarını küçükten büyüğe doğru sıralayınız.
b. Bu kirişleri merkeze olan uzaklıklarına göre sıralayınız.

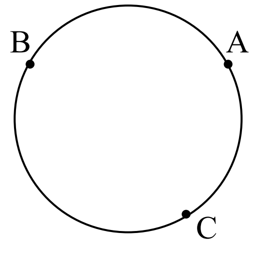
6. Yarıçap uzunluğu 10 cm olan bir çembere, uzunluğu 25 cm olan bir kiriş çizilebilir mi? Neden?

7. Aşağıdaki seçeneklerde verilen çemberlerde gördüğünüz yayları yanlarına yazınız.

a.

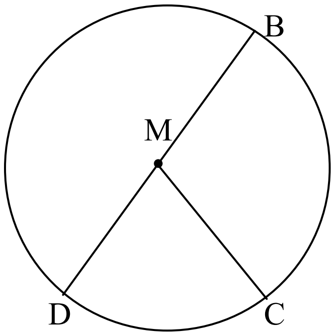


b.

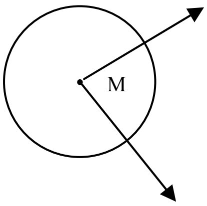


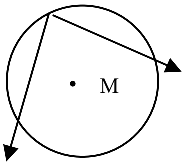
8. Bir doğru bir çembere göre hangi durumlarda bulunabilir? Yazınız ve örnekleri çiziniz.

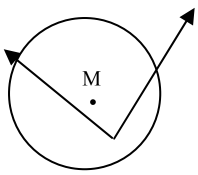
9. Bir doğru bir çemberi en çok kaç noktada kesebilir?
10. Aşağıda M merkezli bir çember verilmiştir. DMC açısı 80° ise BC küçük yayının ölçüsü nedir?

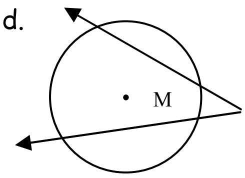


11. Aşağıdaki seçeneklerde gösterilen açıların ne tür açılar olduklarını yanlarına yazın. Adını bilemedikleriniz var mı?

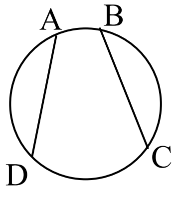
a.


b.


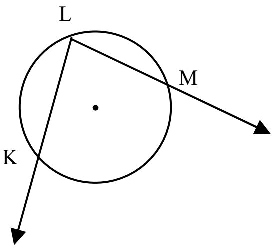
c.


d.


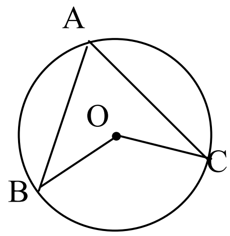
12. Yandaki şekilde [AD] ve [BC] kirişleri eştir, AB ve DC yaylarının ölçüleri toplamı 200° olduğuna göre AD ve BC yaylarının ölçülerini bulunuz.



13. Aşağıdaki şekilde K, L ve M noktaları çemberin üstündedir. KL yayının ölçüsü $110°$, M yayının ölçüsü $90°$ olduğuna göre, KLM açısının ve KM yayının ölçüsünü bulunuz.



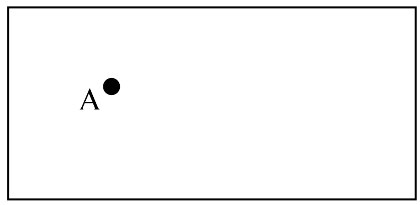
14. Yandaki şekilde BAC açısı çevre açı, BOC açısı ise merkez açıdır. BOC açısı $87°$ olduğuna göre, BC yayının ve A açısının ölçüsünü bulunuz.



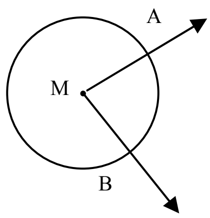
15. Aynı fiyata satılan 10 cm. çaplı pizzayı mı yoksa kenar uzunluğu 9 cm. olan kare pizzayı mı almak daha avantajlıdır?

16. Bir bisiklet tekerleği 62800 m. de 50 kere dönüyorsa tekerleğin çapı nedir?

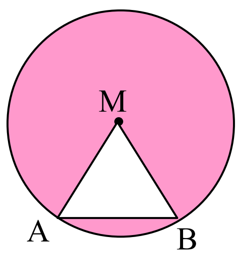
17. Aşağıdaki şekilde bir şeklin haritası verilmiştir. Bu şehirde A ile gösterilmiş noktada bulunan banka bir hırsız tarafından soyulmuştur. Görgü tanıkları hırsızın bir otomobile binip kaçtığını söylemişlerdir. Görgü tanıklarının hırsızın binip gittiğini söylediği otomobil markası saatte 200 km hızla gidebildiği tespit edilmiştir. Bu durumda soygundan 2 saat sonra hırsız kaç kilometrelik bir alan içinde bulunabilir?



18. Aşağıdaki M merkezli bir çember verilmiştir. BMA açısının ölçüsü 85°, |MB| = 10 cm olduğuna göre
a. Küçük ve büyük AB yaylarının uzunluklarını
b. Oluşan küçük ve büyük daire dilimlerinin alanlarını bulunuz.



19. Şekildeki merkezi M olan çemberin bir kirişi [AB] dir. BMA açısı 90°, |AB| = 5 cm olduğuna göre pembe ile taralı bölgenin alanı nedir?



20. Bir silindir hangi geometrik şekillerden oluşur?

21. Bir silindirin açık halini çiziniz. Burada silindirin yüksekliğini gösteriniz.

22. Taban yarıçapı 10 cm olan bir silindirin yanal alanının boyutları hakkında ne söylersiniz?

23. Taban yarıçapı 6 cm, yüksekliği 4 cm olan bir kavanozda satılan fıstık ezmesi 3 milyon lira ise, taban yarıçapı 12 cm, yüksekliği 10 cm olan bir kavanozdaki aynı marka fıstık ezmesi kaç lira olabilir?

24. Bir silindirin içine yüzde 20 daha fazla su koymak için hacmini nasıl değiştirebilirsiniz?

25. Taban dairesinin çapı 1 metre, yüksekliği 2 metre olan silindir şeklinde büyük karton bir kutu yapmak istiyoruz;

a. Bu kutunun alt ve üst kapaklarını yapmak için ne kadar kartona ihtiyaç vardır?
b. Kutunun yanal alanlarını yapmak için ne kadar kartona ihtiyaç vardır?
c. Kutunun tamamını yapmak için toplam ne kadar mukavva kullanılacağını bulunuz.

APPENDIX N

TURKISH EXCERPTS FROM INTERVIEW WITH STUDENTS

(sayfa 106)

Mesela derste izciler olduk. İzciler ateşin çevresinde en iyi şekilde ısınmak için ne yapacaklarını filan düşünüyorlardı Tam bir yuvarlak oluşturduğumuzda hepimizin ateşten eşit ısınacağımızı gördük. Merkezde ateş vardı. Mesela bir ağaç düşünce teğet oluyordu, kiriş oluyordu filan. Drama deyince… geometri çok zor bir ders, işte bu dersi biraz daha kolaylaştırmak için yapılan çalışmalar. Mesela izci kampında, çemberin merkez noktasını ateş olarak tanımladık. Sonra onun etrafında ısınmak için yerleştik. Böylece bir daire oluştu. İşte merkez açıyı öğrendik böylece... Yani kısacası drama zor bir dersi daha kolaylaştırmak için yapılan çalışmalardır (1-S1).

Drama hayatın bir parçasıdır, gerçek hayat gibi. Mesela buradaki rollerimiz, gerçek hayatta olanlar gibi. Mesela bir Örümcek Adam. Biz Örümcek Adamı televizyondan biliyoruz zaten. Sanki gerçekten Örümcek Adamdan mektup almışız gibi oldu. Ve izcilerde gerçek hayattan. İzcilerde zaten normal hayatta ateşin etrafında düzgün bir şekilde sıralanırlar (2-S2).

Drama daha iyi anlamamı sağladı, konulara konsantre olmamı sağladı. Matematik zor bir ders olduğu için, eskiden kolay konsantre olamıyordum. Ama günlük hayat örnekleri derse bağlanmamı sağladı (3-S3).

Günlük hayattan şeyler öğrendiğimiz için zevkli geldi. Daha zevkli olunca da daha iyi anlıyorsunuz. Daha iyi öğrenmemi sağladı bu şekilde (4-S4).

Yaşamdan örneklerle daha eğlenceliydi...Yaşamdan örnekler daha mantıklı geldi... İzciler, günlük hayat örnekleri daha anlaşılır oldu... Drama dikkatimizi çekti, mesela biz izciler böyle yapıyor diye düşündük ve bu bizim ilgimizi çekti (5-S6).

Doğal örnekler verildiği için kamptaki izciler gibi, ağaçlar gibi, daha iyi kavradık (6-S7).

Çizgi film kahramanları, mektuplar, iplerle filan hepsi normal hayattan. Matematiğin hayatımızla ilgili olduğunu anladık (7-S8).

Öğrenmeyi kolaylaştırdı. Örümcek adamla filan öğrenince, sanki oyun gibi oldu, bizde kolay öğrendik...Çemberdeki izci olunca mesela merkez açıyı, çevre açıyı anladım. İzciler benim öğrenmemi etkiledi (8-S9).

Örnekler çevremizdendi. Biz zaten onları biliyoruz, o yüzden ilgilenmek istedik, beynimizi kullanmak izledik.....Günlük hayattan örnekleri işlerken, ne zaman gerekli olacağını gördük. Şimdi ben dışarıda baktığımda, geometrik şekiller oluşuyor kafamda. Bu öğrenmek için güzel bir yol. Matematiğin hep bu şekilde öğretilmesini isterdim. Çünkü günlük hayattan olunca, daha eğlenceli oluyor, daha çok ilgileniyoruz ve katılıyoruz. Çünkü biz hayattaki şeyleri bildiğimiz için, hayatla karşılaştırabiliyoruz (9-S10).

Günlük hayatımızdan olduğu için, bize daha tanıdık geldi. Normal hayatımızda bunlar oluyor zaten. Bu da kolay olmasını sağladı... Öğrendiklerimizin bize ne zaman gerekeceğini görmüş olduk (10-S12).

(sayfa 108)

Mesela sınavda diyelim ki, ben sınıfta yaptığımız şeyleri kolaylıkla hatırladım ve soruları çözdüm. Derste yaptıklarımız kalıcı olmasını sağladı yani (11-S1).

Görerek öğrendiğimiz için, daha kalıcı oldu tabi. Sadece yazıp geçmiyorduk, görerek öğreniyorduk, bu da kalıcı olmasını sağladı (12-S2).

Neyin ne olduğunu öğrendik. Gerçekleri kendimiz bulduğumuz için, aklımızda tutabiliyoruz. Mesela, siz bize π sayısı şudur diye vermediniz. Biz kendimiz bulduk değerini. Siz bize değişik şeyler verdiniz, biz onları gördük, ölçtük, ve biz bir matematiksel bir sonuca vardık. Hangi sayıların üçgen yapabileceğini hangi sayıların yapamayacağını bulduk. Yani bu yüzden daha iyi anladık ve bunların hepsi artık bizim aklımızda ömür boyu kalır (13-S3).

Derste yaptığımız şeyler hep aklımızda kaldı. Örümcek adamı hiç unutmayacağız (14-S5).

Drama yaparak, yaptıklarımız aklımızda kaldı. Biz her şeyi hatırlıyoruz şimdi. “Ben bu etkinliği yapmıştım, hatırlıyorum” diye düşünüyoruz (15-S6).

Kendiniz bulduğunuzda, kendiniz icat ettiğinizde yani, daha çok öğreniyorsunuz, daha iyi öğreniyorsunuz... Eski bilgilerinizi hatırlıyorsunuz, zihninizi tazeliyorsunuz. Böylece de daha iyi öğreniyorsunuz. Etkinliğin içinde olduğunuz için, daha iyi anlıyorsunuz... Bunlar sayesinde, bilinçli ve anlayarak yapabileceğimi fark ettim. Bilinçli olarak yapınca, bilgileriniz sağlamlaşıyor. Bu da kalıcı yapıyor. Mesela kimse üçgen iç açılarını sormayacak normal hayatta ama biz bu bilgilerle günlük hayattaki sorunları çözebileceğiz (16-S8).

Nasıl desem geometrinin temelini öğrendik. Yani biz herşeyin sebebini anladık. İşte direk mesela merkez açı deyip geçseydik, Ne hangi merkez açı? Merkez açı ne? Hemen öyle kolayca öğrenilmiyor ama biz bunu izciler gibi yapınca. İzciler işte nasıl ısınabilir?izciler işte merkezde duran ateşle nasıl alakadar olabilir? Bunların hepsini biz drama yöntemi ile öğrendik. Ama eğer biz bunu böyle yapmasaydık gelip gidiyor gibi bir kulağımızdan girer bir kulağımızdan çıkardı. Hatırlamazdık bir daha (17-S9).

Görerek öğrendiğimiz için ezberci olmadı, kalıcı oldu. Bu da daha iyi anlamamı sağladı ve ezberlemekten kurtardı. Geometriyi sevmeye başladım böylece (18-S11).

Mesela biz şekilleri bedenimizle yaptık. Böylece şeklin nasıl oluştuğunu gördük. Ezberleseydik kısa zamanda unuturduk. Ama öğrenince unutmazsınız. Bu da kalıcı yapar (19-S12).

(sayfa 110)

Ezbere değildi bi kere. Görseldi. Bu yüzden kolay öğrendik (20-S1).

Gözünüzle görerek yaptığınızda, daha etkili oluyor. Bu derste görerek yaptığımız için, daha iyi öğrendik (21-S2).

Matematik sadece açıklamalardı eskiden. Hiçbir görsellik yoktu. Matematikte olmaz, ne gösterilecek diye düşünürdüm. Bu derste bunu gördüm. Günümüzde artık, eğitimin görsel olmasından deneylere dayalı olmasından filan bahsediliyor, drama bunu sağlayabiliyor...Mesela biz π nin değerini bulduk, açıları, üçgenleri filan. Bir üçgenin nasıl oluştuğunu, oluşup oluşamayacağını. Daha bir çok şey gördük. Ve bunların hepsi artık bizim aklımızda ömür boyu kalır. Çünkü görsel eğitim, görerek öğrendik görerek öğrendiğimiz için bizim için daha kalıcı oldu (22-S3).

Görsel olarak gördüğümüzde daha çok ilgileniyoruz ve önemli noktaları daha kolay yakalayabiliyoruz. İlerde hayatımızda karşılaştığımız sorunları da bunun yardımıyla çözebiliriz (23-S8)..

Görerek öğrendik, ve ezberden uzak oldu (24-S11).

(sayfa 110)

Herşey grupça yapılıyordu. Grupça yaptığımızda, birlikte yapmaktan zevk aldık, ayrıca yapabileceğimizi de görmüş olduk (25-S1).

Eskiden herkes kendi başına defterine yazardı, şimdi hep birlikte çalıştık derslerde (26-S3).

Zarflar verdiniz, işte pipet, ipler filan, Bundan üçgen yapılır mı? Şundan üçgen yapılır mı? Yani arkadaşlarımla çalışmamız gerekti. Bize işbirliği yapmayı öğretti. İşbirliği yaptığımızda daha zevkli oluyor ve de yanlış yapmamız daha da zorlaşıyor. Onlarla daha iyi çalıştık motive olduk (27-S4).

Birlikte çalışmayı öğrendik. İşte grup çalışmasında herkesin görevi var, sorumluluk duygusu gelişiyor insanın (28-S7).

Herkes birbirine yardım ediyordu. Dersler bana göre sanki oyun gibi geçiyordu. Ben arkadaşıma bir şey öğrettim, arkadaşım da bana bir şey öğretti. Herkes birbirleriyle bilgi alışverişinde bulundular. Bir şey yaparken başkasının neler yaptığını da gözlüyorduk. Bu da öğretici oldu (29-S9).

Birlikte çalıştık, birbirimize yardım ettik. Anlamadığımız şeyleri birbirimize sorabildik.... Düşündüklerimizi arkadaşlarımıza söyledik ve arkadaşlarımızla tartışabildik, onlarında fikirlerini aldık, o zaman arkadaşlığımız da gelişti (30-S10).

Birlikte çalıştık, çalışırken, birimizin eksiğini öbürümüz kapattı (31-S11).

(sayfa 111)

Sınıfta müzik olması eğlenceli yaptı geometriyi (32-S1).

Kesinlikle daha eğlenceliydi. Mesela kendi ellerimiz, kollarımızla, iplerle filan geometrik şekilleri oluşturmak eğlenceliydi. Omzumuzla, dirseğimizle, burnumuzla şekilleri çizmek eğlenceliydi. Eğlenceli olduğu içinde daha iyi anladık. Gerçek hayattan mesela izciler, NASA'daki roket filan benim ilgimi çekti yani. Mesela örümcek adam filan gibi bizim öğrenmek istediğimiz şeylerle de ilgiliydi. Yani bunlar eğlenceli olmasını sağladı (33-S4).

Ben bize verdiğiniz forma geometriyi sevmiyorum diye yazmıştım. Ama şimdi duygularım değişti bu derste. Yani eğlenceliydi. Dramayla olunca öğrenmek hoşuma gitti (34-S5).

Canlandırmalar yaptığımız için, kendimiz birşeyler oluşturduğumuz için ya da başka eşyalarla oluşturduğumuz için eğlenceli oldu (35-S7).

Derste ayakta olmak, sınıfın içinde dolaşabilmek, başkaları bir şeyler yaparken görmek onları. Bir de şimdi sınıfta herkes beni görüyor diye düşünmek bile eğlenceli oluyordu. Katılmak hoşuma gitti.....Çocuk gözüyle baktığınızdan dolayı eğleniyordunuz (36-S8).

Eğlenceliydi. Ne öğrendiğimiz öğrendik. Bazı şeyleri canlandırdık. Bu da eğlenerek öğrenmemizi sağladı. Zamanın nasıl geçtiğini anlayamıyorduk (37-S9).

Geometri daha eğlenceli oldu. Daha kolay oldu. Hayattan örneklerle, zevkli hale geldi (38-S10).

Ezbere olmadığı için daha çok sevdim (39-S11).

Drama bence aynı eğlenceli bir oyun gibi....Mesela biz izciler olduğumuzda, konular bize daha eğlenceli geldi ve daha çok anladım ben (40-S13).

(sayfa 112)

Ders işlenirken mesela konuşulması anlamamızın birazcık daha azalmasına sebep oldu. Sınıfımız bir 34 kişi olacağına 20 kişi olsaydı disiplin daha iyi sağlanabilirdi. Çünkü konuşan kişi az olacaktı. Öğretmenler disiplini daha iyi sağlayabilecekti. Bir 34 kişiyle sağlamak başka 20 kişiyle sağlamak başka. Bazen sadece oyun oynadıklarını düşünüyorlardı (41-S3).

Bence biraz daha ilgi gösterilebilirse, çok daha bir ortam olur. Yine de sınıfta bir ses oluyor, daha da sessiz olabilir sınıf (42-S6).

Dramada hoşuma gitmeyen bir şey yoktu da dediğim gibi, ders kaynıyor gibi herkes konuşuyordu bazen, konuşulduğu içinde pek bir şey anlayamıyorsun. O yüzden. Öğretmen biraz kızsaydı konuş
anlara iyi olurdu (43-S11).

Rahattık ama rahat olunca disiplinden bazı şeyler kaybediliyor. Bence bazı çocuklar cezalandırılmalıydı (44-S12).

Öğrenciler çok konuştukları için bu olabilir. Dersle ilgili olsa bile gürültü iyi bir şey değil (45-S13).

(sayfa 113)

Hoşuma gitmeyen şey sadece fazla soru çözmedik, o kadar (46-S5).

(sayfa 113)

Mesela kavga ettiğiz arkadaşlarla zaten o konu üzerine yoğunlaştığımız için onu unuttuk daha iyi oldu aramız. Mesela, pipetler, iplerle çalışırken, konuşup tartışmak zorunda kaldık arkadaşımızla. Hem arkadaşlarımızla düşünceleri tartışarak, düşüncelerimiz gelişti (47-S2).

Bir şeyleri öğrenmek için beraber çalışmamız gerekiyordu. Şartlar bunu gerektiriyordu. Bundan dolayı birbirimizle kaynaştık... Şimdi arkadaşlarımla daha samimiyim. Hiç daha önce tanışmadığımız samimi olmadığımız arkadaşlarımızla da daha çok samimi oldum. Bundan dolayı da arkadaşlık ilişkilerimde bana yardımcı oldu (48-S3).

Arkadaşlarımla çalışınca daha iyi anladığı gördüm. Bundan sonra onlarla çalışmanın daha iyi olacağını biliyorum... Arkadaşlarımı biraz daha tanıdım. Mesela Öğrenci x. O herkesten uzak kalan birisiydi. Ama birlikte bir şeyler yaptığımızda onun aslında kötü biri olmadığını anladım. Arkadaşlığım ilerledi (49-S5).

Yani daha önce hiç böyle bir etkinliği birlikte yapmadığımız kişilerle, aramızda bir bağ oldu, yakınlaştık zaten (50-S6).

Yani beraber olunca, bir fikri aynı anda söyleyince böyle aranızda bir bağ oluşuyor, fikir bağı, düşünce bağı ya da görüş bağı. Ortak noktalar bulduk, şeylerde bulunduk aynı dramalarda bulunduk, böylece birbirlerimize ısınmamız arttı (51-S8).

Grupça çalışma yaptık, yardımcı olduk birbirimize. Bilemediğimiz konularda, onların görüşünü alarakta yine şeyaptık. Arkadaşlarımızla bi çok konuda tartıştık, kendi fikirlerimiz söyledik, bu şekilde yani arkadaşlarımız, dostluklarımız daha da gelişti (52-S10).

Konuşmadığımız arkadaşlarla bir arada olduk, bir şeyler yapmaya uğraştık (53-S12).

İşte birlikte daha çok konuşmaya başladık. İşte mesela konuşmadığımız arkadaşlarla konuşmaya başladık. Mesela Öğrenci xle. Bir grup çalışmasını birlikte yaptık. Birlikte ölçtük. O zamanda samimi olduk. Mesela ben bilmediğim soruları yani hiç kimseye sormuyordum. Şu anda arkadaşlarıma gidip soruyorum bilmediğim soruları (54-S13).

(sayfa 115)

Eskiden konuşmayı sevmezdim. Daha çok konuştum bu derste. Derse eskisinden çok katılıyormuşum onu gördüm.... Bu kadar zeki olduğumu bilmiyordum. Bazı şeyleri bilince böyle düşündüm, zeki olduğumu düşündüm (55-S1).

Kendim bir şeyleri yarattım yani nasıl söylesem bir şeyleri oluşturduğumu gördüm. Yeni birşeyler ortaya çıkarttığımı gördüm (56-S3).

Derste dramayla daha iyi anlayacağını öğrendim. Arkadaşlarımla çalıştığımda daha iyi öğreneceğimi anladım. Arkadaşlarıma bir şeyler öğretebildiğimi gördüm (57-S5)..

Arkadaşlarıma öğretebileceğimi gördüm (58-S10)..

(sayfa 115)

Mesela ben önceden, yani bu kadar iyi değildi matematiğim. Bu sene çok daha iyi oldu. Yani kendimi tanıdım. Matematiğim iyi benim ve de gelecekte bu konularda ilgilenebilirim diye düşündüm..... Mesela ben geometriyi hiç beceremezdim, hiç yapamazdım. Ama sonradan birden eğlenceli geldi hep yapmaya başladım. Kendimi tanıdım gerçekten bilmiyorum bu özelliğimi, geometriyi sevdiğimi, yapabildiğimi (59-S2).

Geometri zevkliymiş dedim. Zor geometri problemlerini bile yapabiliyormuşum dedim. Eskiden offffff geometri sıkılıyorum sinirleniyorum filan diyordun çalışırken ama şimdi çok zevkli güzel geliyor insana ve seviyorum (60-S9).

Ya ben matematiği aslında hiç başaramayacağımı şeyapıyordum işte çözemem filan yapıyordum. İşte drama olunca daha etkinliğim oldu. Mesela işte düşüncelerimi hocaya söylediğimde hocanın kızmayacağını şeyaptım... yani herşeyi açıkça söylememi sağladı. Şimdi matematikte başarılı olabileceğime inanıyorum (61-S13).

(sayfa 116)

Yani şey olarak bir şey öğrendiğim zaman kendime güvenebileceğimi öğrendim (62-S4).

İstesem aslında herşeyi yapabilirim. Onu anladım (63-S6).

Eskiden ben kendime aslında güvenmezdim, güvensiz bir insanımdır. Ama burada birşeyler yaptıkça, katıldıkça yani daha güvenim arttı kendime matematikte, geometride.... Kendime güvenim artıyor mutlu oluyorum (64-S8).
Bazı şeyleri kendi başıma anlayabileceğimi anladım, başkaları bana açıklamadan yani (65-S10).

(sayfa 117)
Herkes bir şeyler deniyordu. Mesela pipetlerle çalışıp, üçgen yapılabilir mi yapılamaz mı diye bakıyorduk, ya da yoğurt kapağının çevresini ölçüyorduk, grup arkadaşımız çapına bölüyordu mesela. Herkes bir şey yaptı. Öğretmen sadece cevabı, sonucu filan yazdı (66-S12).
Herkes, korkusuzca atılgan bir şekilde derse katılabiliyor şimdi (67-S2)
Eskiden hoca kaldırıyordu. Şimdi bizzat biz kendimiz yapıyoruz. Önceden yazıyorduk ve soru cevaplıyorduk bunda birebir biz drama yapıyoruz zaten. O zaman daha iyi oluyor. Daha iyi anlıyoruz (68-S4).
Bir de dramayla olunca insan zorunlu kaldı birazcıkta. Katılma zorunluluğu oldu. Ve böylece hiç çalışmayan arkadaşlarımız bile katılmak zorunda oldu derse. Mesela Öğrenci x, Öğrenci y, Öğrenci z, ve Öğrenci w. Onlarda tahtaya kalktılar, bizler için açılar oluşturdular. Onlar içinde bir eğlence oldu hiç değilse yaptıkları konuları daha iyi anlama fırsatı buldular (69-S5).
Gözlemime göre, derse katılmayan öğrencilerde, derse katıldılar bu derste. Mesela ben eskisinden daha çok katıldım. Şımarık arkadaşlar bile daha çok katıldılar. Herkes birşeyler söylemek için, katılmak için parmak kaldırıyordu (70-S6).
Mesela ölçümler yaparken, üçgen, dikdörtgen gibi şekilleri oluştururken, grupça çalışıyorduk (71-S7).
Öğretmen bize sorular sorardı, bizde cevap verirdik. Sadece bizim konuşmamız o kadardı. Ama şimdi yani dersin içinde biz varız. Sanki biz işliyoruz dersi, başkalarına biz veriyoruz dersi. İşte biz mesela yapıyoruz, tahtaya yazıyoruz, dramatize ediyoruz burda. Öğretmenin rolünü biz oynuyoruz sanki (72-S8).
Dersle ilgisiz şeylerle filan meşgul olurduk eskiden, şimdi dersle ilgili çalışıyoruz. Herkes birlikte çalışıyor, fikirlerini, düşüncelerini aktarıyor (73-S9).

(sayfa 118)

Eskiden sırf yazıyorduk oturduğumuz yerde. Şimdi hep konuşuyoruz. Çünkü öğretmen hep soruyor. Sorunları çözmek, problemi çözmek için, bir şeyleri tartışıp duruyoruz... Bunları yaparken herkes fikirlerini özgürce söylüyor. Bir şeyleri bulunca, fikirlerimizi söyleyince mutlu oluyoruz. Herkes fikrini söylüyordu, teneffüslerde bile tartışıyorduk bununla ilgili (74-S1).

Mesela, ipler ve pipetlerle çalışırken, arkadaşlarımızla konuştuk. Onlarla ilgili tartıştık, düşüncelerimiz gelişti. Bu da daha iyi öğrenmemi sağladı (75-S2).

Herkes tek başına çalışırken, artık birlikte tartışıyoruz. Belli bir konuya odaklanıp onunla ilgili konuşuyoruz. Fikirlerimiz özgürce söyleyebiliyoruz (76-S3).

Derslerde, biz bir şeyleri açıklamak zorundaydık. Her derste katılmak ve fikirlerini söylemek gerekiyordu (77-S7).

Öğrenciler dinlerdi yani hocanın anlattığını şimdi bir bakıma öğrencilerde anlatıyor (78-S11).

(sayfa 119)

Eskiden oturup sıkılarak bir şeyler yazardık. Matematik zor olduğu için arkadaşlarım sevmiyorlar, yapamadıkları için. Ama şimdi herkes korkmadan rahatça çalışabiliyor. Şimdi sorularla, beyinlerimiz uyandı ve bunu çözebilirim diye düşündük (79-S2).

Derste biz bir şeyler açıklamak zorundaydık, derse katılmak gerekliydi mutlaka. Oturup yazmak yerine, etkinliklere katıldık. Beynimizi kullandık. Derse bizde bir şeyler ekledik (80-S7).

Derse daha da bağlandık. Dersi daha da sevdik. Daha da katıldık. Hepimiz kafamızı çalıştırmak zorunda kaldık (81-S10).

Öğrenciler sırada uyur gibi otururlardı eskiden. Şimdi herkes birlikte çalışıyor ve atılgan gibi parmak kaldırıyor (82-S13).

(sayfa 119)

Şimdi sınıfta daha rahat (83-S12).

Herkes sınıf içinde dolaşabiliyor rahatça, herkes serbestleşti şimdi. (84-S13).

(sayfa 119)

Normalde öğretmen tahtaya bir şey yazıyor biz sonra deftere yazıyorduk. İşte böyle biraz sıkıcı oluyor. Ama dramayla yapınca öğretmenin şeyi, öğretmenin biraz daha etkisi azalıyor. Öğretmen bize sorular soruyor, cevapları hazır vermiyor önce. Hep kendimiz yapmaya çalışıyoruz. Bizim yaptıklarımızdan doğru olanlarda tahtaya yazılıyordu. Öğretmen geometriyi biraz oyun haline getiriyordu. Daha da basitleştiriyordu (85-S1).

Yani eskiden hep, sürekli tahtaya filan yazıyorlardı. Sıkıcı oluyordu, hep aynı şeyleri resmen geçiyorduk. Ama, öğretmen soru filan soruyor, ipucu veriyor. Şimdi kendi beynimiz gelişti. Hepimiz mantıksal ilerlemeye geçtik (86-S2).

Öğretmen gibi anlatmadı konuları önce. Biz kendimiz yaptık kendimiz bulduk o sadece bizi yönlendirdi, ipucu verdi. Öğrencilerin istediklerini söyleyebilmelerini sağladı bu durum. Çünkü karşıda kızmayan biri var. Onun dışında düşüncelerini rahatça ifade edebilmesini… Yanlışlarını korkmadan söyleyebilmesini… Bilgilerini tazeledi sonuçta bu şekilde davranışlar (87-S3).

Eski öğretmenimiz konu direk anlatıyordu. O konu ile ilgili alıştırma çözdürüyordu defterlerimize filan. Soru sormuyordu fazla. Zevkli olmuyordu ders. Zevkli olan herşey daha iyi anlaşılıyor o yüzden daha iyi anlaşıldı şimdi (88-S4).

Öğretmen bize yolu gösterdi, fazla açıklamadı (89-S6).

Öğretmen bizden bir şeyleri açıklamamızı istedi. Daha iyi anlamamız için canlandırmalar yaptırdı (90-S7).

Eskiden öğretmen konuları anlatır giderdi. O şekilde bizde ilgilenmezdik. Şimdi çevremizden fazla örnek veriyor. Çok zevkli geçti dersimiz. Öğretmen hiç konuyu anlatmadı genelde. Genelde siz söylediniz, biz bulduk herşeyi (91-S10).

Öğretmen anlatıyordu, şimdi biz anlatıyoruz. Grup içinde tartışarak öğreniyoruz. Aynı konu üzerinde konuşarak öğreniyoruz konuları. Şimdi biz kendimiz konunun anlatılmasına yardım ediyoruz öğretmene sanki (92-S11).

Öğretmen konuyu açıklardı önceden. Şimdi grupça yapıyoruz. Öğretmende dersten zevk aldığı anlaşılıyor. Öğretmenin dersteki gülüşünden anlıyorum (93-S13).

(sayfa 121)

Öğretmeni daha yakın hissetmeye başladık kendimize. Öğretmen olarak değil de biraz daha arkadaş olarak görmeye başladık. Zaten mesela bir izci lideri oldu, başka şeyler filan oldu dramalarda. Örümcek adamdan mektuplar getirdi. Yani gerçek öğretmen gibi değil de arkadaş gibi görüyorum (94-S5).

Daha rahattık. Hoca kızmıyor birşey bilemediğinizde. Arkadaş gibi abla gibi oldu (95-S12).

APPENDIX O

TURKISH EXCERPTS FROM INTERVIEW WITH TEACHER

(sayfa 121)

Fikirlerini ifade etmeleri için şansları oldu bence. Birbirlerinin fikirlerini eleştirdiler. Normal derslerde pek yapmadığımız şeyler bunlar. Çocuklara bu kadar çok konuşma hakkı vermiyoruz. Versek bile çocuklar ciddiye almadıkları için, kısa kesiyoruz, kendimiz anlatıyoruz alan alır almayan almaz diye. Burda da ilk başta biraz çekindiler ama kendilerine söz hakkı verilince, en ilgisiz çocuk bile dersle ilgileniyor. Arkadaşlarım konuşuyor, bir şey söylüyor... Ne oluyor bitiyor anlamaya çalışıyor yani (1).

(sayfa 122)

....Daha kalıcı oldu. İleride sınıfta yaptıkları eğlenceli şeyleri hatırladıklarında geometri konusunu da hatırlamış olacaklar bu çocuklar (2).

(sayfa 122)

Grupça bir şeyler yapmayı öğrendiler. Normalde grupça çalışma fırsatı veremiyoruz. Grup çalışmasıyla birlikte çalışmayı öğrenciler, arkadaşlarından bir şeyler öğrendiler, arkadaşlarına bir şeyler öğrettiler (3).

(sayfa 122)

Öğrencilerin hayal güçlerini ve yaratıcılığını geliştirdiğini düşünüyorum. Kendilerine güvenleri geldi. Derse katıldıkça, katılabileceklerini, başarabileceklerini anladılar dikkat ederseniz. Eskiden başarısız olan öğrenciler bile derse katıldılar (4).

(sayfa 122)

Konular ilginç bir şekilde verildi. Ders öğrencilere zevkli geldi, hoşlarına gitti, onları motive etti. Dikkatleri sürekli derste oldu. Ders zevkli geldiği için matematiği daha çok anladılar. Bu da daha çok sevebilmelerini sağlar. O açıdan iyi oldu.... Bir de zaten kafaları dersle meşgul olmak zorundaydı (5).

(sayfa 123)

Çok güzel etkinlikler, çok olumlu bakıyorum ama bunları yönetmek için çok sabır lazım. Her ders için bir takım şeyler hazırlamak lazım. Mesela her ders bir şey getirdiniz, silindir, fener, ip, makas filan gibi, ne biliyim kağıtlar, resimler gibi yani.. İşte bazılarını hazırlamak gerekiyor, bazılarını almak gerekiyor. Yani hem uğraştırıcı, vakit alıcı, hem de masraflı bence. Mesela her gün 7 saat dersi olan bir öğretmen bu kadar hazırlıklı gelemez. Tabi birde derste yapılanları planlamak var. Yani işte izciler, oyunlar filan bunları bulmak için yaratıcı olmak lazım. Her öğretmen bu şekilde hazırlayamaz derslerini (6).

(sayfa 123)

Sınıf düzeni böyle etkinlikler için pek uygun değil. Siz her dersin önceki teneffüste sıraları değiştirdiniz filan ama, öğretmenler bunu her ders yapamaz. Çünkü teneffüs öğretmenin hakkı, 5 dakika dinlenmek istiyoruz. Bütün gün kafamız şişiyor, idaresi ayrı, öğrencisi ayrı. O yüzden sıraları düzeltmekle filan uğraşmaz öğretmen. Ya da öğrencilere filan yaptırmak lazım. Öğrencileri görevlendirip o şekilde yapabilirsiniz (7).

(sayfa 124)

Bu etkinliklerin sonunda fazla soru çözemediniz. Bence konuların pekişmesi için bol bol soru çözmek lazım. Yani matematik, bir Türkçe, fen bilgisi dersinden farklı. Drama yapınca soru çözmeye fazla zaman kalmadı. Müfredatımız çok yüklü. Dersler böyle işlenirse ya soru çözemezsiniz, soru çözmeye kalksanız da konular yetişmez (8).

(sayfa 124)

Yani en büyük olumsuz yanı bence, öğretmene şimdikinden daha çok iş düşüyor. Sıraları düzelt, her gün değişik değişik, öğrencinin ilgisini çekecek dersler planla...birde değişik araç gereç yapmak lazım, bulup getirmek lazım. Yani bunlar yaygınlaşsa, öğretmenlere kitap, araç gereç dağıtılsa bizde bu şekilde ders işleyebiliriz. Ama elimizde kaynak olması lazım dediğim gibi (9).

(sayfa 124)
Küçük sınıflarda uygulanması daha kolay olur (10).

(sayfa 124)
İyi sınıflarda uygulanması gerektiğini düşünüyorum. Eğer çocuklar başarılıysa, daha çok katılır, daha iyi düşünür, daha iyi cevap verir, daha iyi soru sorar. Kapasitesi olan çocuklarla yapılmalı. Çocuklar zayıfsa, soru çözmeye filan daha çok ağırlık verilmeli (11).

APPENDIX P

RAW DATA

Table P.1 Raw data of the study

NO	GROUP	GENDER	MGP	PREVHL	PREMAS	PREGAS	POSTVHL	POSTMAS	POSTGAS	POSTAPA	POSTCCA	DELAPA	DELCCA
1	1	1	4	8	96	51	10	96	57	186	27	-	-
2	1	1	3	10	88	27	7	64	44	198	22	138	9
3	1	1	2	11	64	30	9	74	44	58	21	93	20
4	1	1	4	10	53	34	8	58	44	136	16	-	-
5	1	0	2	5	54	25	10	21	52	207	20	134	13
6	1	1	4	6	81	48	6	91	53	219	32	162	34
7	1	0	2	6	49	20	9	39	12	182	15	132	10
8	1	0	5	5	86	56	13	90	56	191	33	152	17
9	1	0	2	9	49	41	8	48	37	115	16	0	6
10	1	0	3	9	49	14	8	20	51	136	15	137	10
11	1	1	3	8	96	57	15	79	42	202	22	138	18
12	1	1	2	2	54	41	7	66	31	51	16	-	-
13	1	1	2	6	87	30	5	79	45	73	13	65	10
14	1	1	3	7	87	41	7	69	49	192	24	154	22
15	1	0	5	10	75	47	8	71	48	256	36	150	31
16	1	0	4	10	78	25	9	66	47	192	29	139	29
17	1	1	5	7	51	31	9	100	57	204	28	132	27
18	1	0	4	5	24	11	6	100	60	186	15	145	12
19	1	0	5	7	66	59	15	63	55	225	31	188	32
20	1	0	3	9	76	31	10	62	41	169	10	127	12
21	1	1	4	7	86	49	9	74	44	190	34	149	31
22	1	1	2	6	77	43	10	63	47	153	24	106	30
23	1	0	2	7	33	19	7	58	36	117	17	135	14
24	1	1	2	6	92	42	12	100	52	114	10	121	1
25	1	0	2	9	43	28	5	60	17	66	15	125	12
26	1	1	2	8	61	33	8	57	39	19	13	99	10
27	1	0	2	6	90	49	12	61	57	177	20	152	13
28	1	1	4	11	63	41	5	68	44	163	22	139	23
29	1	1	2	3	53	37	4	60	56	87	13	-	-
30	1	0	2	6	44	27	6	61	25	160	17	186	10
31	1	0	4	4	98	58	14	91	56	244	30	167	25
32	1	1	3	8	67	36	9	36	15	151	17	120	14
33	1	0	4	7	79	20	12	75	24	220	34	136	35
34	1	0	3	5	31	30	9	69	44	139	26	159	27
35	1	0	3	8	77	54	11	77	53	196	30	137	29

Table P.1 (continued)

NO	GROUP	GENDER	MGP	PREVHL	PREMAS	PREGAS	POSTVHL	POSTMAS	POSTGAS	POSTAPA	POSTCCA	DELAPA	DELCCA
36	1	1	2	9	20	20	10	32	16	151	19	103	16
37	1	1	4	7	72	18	11	80	50	187	27	78	2
38	1	1	3	7	33	50	9	84	20	177	12	95	12
39	1	1	2	5	79	30	5	68	35	148	17	129	12
40	1	0	5	8	26	29	10	64	48	235	34	203	42
41	1	0	2	5	39	42	6	34	32	152	17	119	15
42	1	0	2	6	48	39	6	54	56	194	24	204	26
43	1	0	2	5	54	42	5	62	37	118	11	87	12
44	1	1	5	9	67	35	10	51	59	252	33	136	33
45	1	0	5	10	39	50	12	81	50	211	40	163	38
46	1	1	4	6	62	29	10	55	51	192	34	151	37
47	1	1	4	8	32	33	9	52	43	179	16	108	19
48	1	0	2	6	23	46	8	42	21	131	14	118	7
49	1	0	4	6	74	54	7	63	33	189	30	160	29
50	1	1	2	8	76	44	10	40	36	137	15	112	20
51	1	0	2	9	40	16	9	20	12	217	22	173	19
52	1	0	3	9	90	51	12	99	57	164	16	-	-
53	1	1	2	9	74	43	11	66	46	,	0	0	1
54	1	0	3	5	51	46	8	53	37	166	16	135	19
55	1	0	3	8	20	14	9	20	15	194	20	178	15
56	1	0	4	7	78	43	7	72	40	253	21	171	22
57	1	0	4	7	20	16	9	42	45	166	30	169	0
58	1	1	3	8	70	43	9	67	36	210	21	132	29
59	1	0	2	8	55	19	8	60	21	132	15	138	12
60	1	1	3	5	79	51	6	59	53	161	27	123	25
61	1	0	3	6	53	31	8	83	55	148	16	82	13
62	1	0	3	8	67	37	9	67	24	182	20	110	17
63	1	0	5	9	74	51	9	93	54	252	37	218	43
64	1	0	5	10	48	29	10	99	60	246	30	165	30
65	1	0	5	7	88	41	8	83	50	222	39	210	44
66	1	0	2	9	23	51	6	28	13	269	18	159	24
67	1	0	3	9	32	23	11	29	19	198	13	175	12
68	1	0	5	6	100	60	13	99	60	243	42	227	44
69	2	1	4	11	48	26	3	47	25	47	5	81	1
70	2	1	5	9	95	55	5	64	38	126	10	80	4
71	2	0	4	1	53	30	2	42	21	59	4	1	1
72	2	0	4	10	76	41	7	62	54	138	13	120	3
73	2	0	4	10	65	23	6	65	46	60	12	44	7
74	2	0	3	8	64	19	7	66	30	104	9	74	4
75	2	1	2	11	44	25	8	32	12	55	3	51	1
76	2	1	5	9	61	44	9	67	34	133	23	99	11
77	2	0	4	8	39	73	7	66	35	63	10	95	4

Table P.1 (continued)

NO	GROUP	GENDER	MGP	PREVHL	PREMAS	PREGAS	POSTVHL	POSTMAS	POSTGAS	POSTAPA	POSTCCA	DELAPA	DELCCA
78	2	0	3	11	58	30	10	29	25	80	6	73	2
79	2	0	3	9	24	12	7	24	12	70	3	55	1
80	2	0	3	9	40	23	2	20	16	106	12	115	2
81	2	0	2	3	92	48	8	29	16	31	2	86	1
82	2	1	2	6	29	23	6	27	17	102	4	66	1
83	2	0	3	7	25	43	6	24	45	119	21	101	3
84	2	1	2	10	71	30	7	59	46	97	7	58	2
85	2	0	3	2	31	32	1	64	39	36	6	73	0
86	2	0	5	12	76	51	10	74	46	174	34	173	9
87	2	1	2	9	65	35	4	46	40	121	12	45	3
88	2	1	4	10	52	20	9	54	29	30	12	81	3
89	2	0	2	6	85	42	6	57	46	119	18	92	2
90	2	0	4	15	19	12	1	24	18	78	9	64	7
91	2	0	4	8	63	26	8	54	24	122	9	115	5
92	2	0	3	9	31	36	8	28	18	125	7	109	3
93	2	1	2	11	87	37	4	61	42	26	3	-	-
94	2	1	2	8	29	24	8	95	31	134	10	61	3
95	2	0	3	10	76	44	5	45	33	82	7	144	4
96	2	0	4	10	20	14	6	41	12	79	12	105	4
97	2	1	5	10	36	32	8	56	50	121	12	66	5
98	2	0	3	9	29	13	5	40	33	110	7	137	0
99	2	0	3	10	48	28	5	75	59	82	7	64	1
100	2	0	4	8	46	24	7	41	35	140	13	134	5
101	2	1	2	3	13	24	3	26	23	27	3	35	1
102	2	0	2	10	59	35	5	87	56	119	6	102	2

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